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RECORD OF DECISION

BOOMSNUB/AIRCO SUPERFUND SITE
HAZEL DELL, WASHINGTON

February 2000

U.S. Environmental Protection Agency

Region 10

Boomsnub/Airco Superfund Site
Record of Decision

DECLARATION

Site Name and Location

Boomsnub/Airco Superfund Site
(aka Boomsnub/BOC Gases)
Hazel Dell, Washington

CERCLIS ID # WAD009624453

Statement of Basis and Purpose

This decision document presents the selected remedy for the Boomsnub Soil Operable Unit and the Site-Wide Ground Water Operable Unit at the Boomsnub/Airco Site, in Hazel Dell, Washington. The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and, to the extent practicable, the National Oil and Hazardous Substances and Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this Site.

The U.S. Environmental Protection Agency (EPA) is the lead agency for this Site. The State of Washington concurs with the selected remedy.

Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment, or from threatened releases of pollutants or contaminants from this Site that may present an imminent and substantial endangerment to public health or welfare.

Description of Selected Remedy

The Boomsnub/Airco Superfund Site consists of two industrial facilities and a ground-water contaminant plume. Boomsnub operated a chrome plating facility resulting in historical spills of chromic acid that entered soils on their property and migrated to ground water. BOC Gases, located adjacent to the Boomsnub property, is an active compressed gases facility. Historical practices at the BOC Gases property have resulted in the presence of volatile organic compounds (VOCs) in soils and ground water. Releases of chromium and VOCs from the Boomsnub and BOC Gases properties, respectively, have resulted in a commingled plume extending approximately 4,400 feet. EPA has divided this Site into three operable units (OUs) to manage these cleanup activities:

- Boomsnub Soil OU
- BOC Gases Soil OU
- Site-Wide Ground Water OU

This Record of Decision addresses two of three OUs at the Site, the Boomsnub Soil OU and the Site-Wide Ground Water OU. The BOC Gases Soil OU is being addressed under a removal action for source control of ground water within the BOC Gases property boundaries to prevent continued migration of volatile organic compounds to the Site-Wide ground-water plume.

The major response activities at this Site to date include the following:

- Removal of 6,051 tons of chromium-contaminated soils at the Boomsnub Soil OU in a removal action by EPA in 1994.

- A Record of Decision dated September 29, 1997, for an interim action ground-water pump and treat system using air stripping to treat volatile organic compounds and ion exchange to treat hexavalent chromium for the Site-Wide Ground Water OU. The 1997 Record of Decision allowed EPA to continue operation of the ground-water pump and treat system installed by the Washington State Department of Ecology, and operated at a capacity of 100 gallons per minute by EPA since 1994.

Investigations are complete for the BOC Gases Soil OU. VOCs were found near the water table on the property. A source control measure to prevent VOCs from migrating off the BOC Gases property via ground water is anticipated. The source control action for the BOC Gases Soil OU will be documented in an Action Memorandum by EPA. This selected remedy for the Site-Wide Ground Water OU assumes implementation of, and will be compatible with, the alternatives being evaluated for source control at the BOC Gases Soil OU.

The major components of the remedy for the Site-Wide Ground Water OU are the following:

- Continued ex-situ ground-water treatment with ion-exchange and air stripping, discharging treated ground-water to the City of Vancouver Publicly Owned Treatment Works (POTW)

- Increased treatment capacity of the interim action pump and treat system from 100 gpm to a minimum 200 gpm, including additional wells, piping and treatment plant upgrades

- Expanded treatability testing of in-situ ground-water treatment via modified in-well stripping for potential use as a contingent ground-water remedy

- Institutional controls in the form of public notice and long-term compliance monitoring for contaminated ground water, and Site access restrictions of the Boomsnub property for the duration of the pump and treat system's operation.

Pump and treat is a foundation of the final selected remedy for the Site. The interim action has successfully removed 20,000 pounds of chromium and 1,700 pounds of trichloroethene. By increasing the capacity of the extraction network and ground-water treatment system, EPA expects to optimize the removal of chemicals of concern. EPA will reevaluate performance of the 200 gpm pump and treat system within five years from the date of this ROD to consider information from treatability testing, optimization of the pump and treat system, and other relevant information (e.g., status of long-term effectiveness of permeable reactive barriers at similar sites). It may become apparent that use of another technology (alone or in conjunction with pump and treat) will further increase the efficiencies of contaminant removal from ground water. Implementation of additional technologies to enhance the remedy is consistent with EPA guidance document *Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (EPA 540-R-96-023, October, 1996).

The major components of the remedy for the Boomsnub Soil OU are the following:

- Excavation and off-site disposal of an estimated 878 cubic yards of soil exceeding a remediation level of 400 ppm for total chromium and the MTCA Method A industrial soil cleanup standard of 1,000 ppm for lead
- Other co-located contaminants including arsenic and five semi-volatile organic compounds (SVOCs) will also be addressed by this action, allowing future industrial use of the property
- Institutional controls in the form of deed restrictions and controlled site access for the Boomsnub property to prevent soil contamination below 15 feet in depth from being disturbed without appropriate precautions and to preclude residential use of the Boomsnub property.

The principal threat waste, hexavalent chromium in soils, was mostly addressed in the 1994 soil removal action by EPA. This selected remedy will include excavation of the highest contaminant concentrations, and treatment if necessary, prior to disposal at a Resource Conservation and Recovery Act (RCRA)-approved landfill. The low-level threat waste, lead in soil, will also be addressed by excavation of soils to eliminate potential exposures to future workers. The remaining chromium and VOC contamination in Site-Wide ground water will be addressed by continued operation of the ground-water pump and treat system, and other actions which may be implemented as part of the contingency remedy provisions in this ROD.

ROD Data Certification Checklist

The following information is included in the *Decision Summary* section of this Record of Decision. Additional information can be found in the Administrative Record for this Site.

- ✓ Chemicals of concern (COCs) and their respective concentrations (Section 5.0, Tables 5-1 and 5-2)
- ✓ Baseline risks represented by the COCs (Section 6.1.5, Tables 6-1, 6-2, 6-3, and 6-4)
- ✓ Cleanup levels established for COCs and the basis for the levels (Section 7.0, Tables 7-1 and 7-2)
- ✓ Current and future land and ground-water use assumptions used in the baseline risk assessment and ROD (Section 5.5)
- ✓ Land and ground-water use that will be available at the site as a result of the Selected Remedy (Section 10.4)
- ✓ Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (Section 10.3 and Tables 10-1 and 10-2)
- ✓ Decisive factor(s) that led to selecting the remedy (Sections 10.1.1 and 10.2.2)

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent possible. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of hexavalent chromium in soils comprising principal threats through treatment and treatment of ground water). Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted every five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Chuck Clarke
Chuck Clarke
Regional Administrator
Region 10
U.S. Environmental Protection Agency

2-3-00
Date

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ABBREVIATIONS AND ACRONYMS

amsl	above mean sea level
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirements
ASL	above screening value
ASTM	American Society for the Testing of Materials
bgs	below ground surface
BOC	BOC Gases
BPA	Bonneville Power Administration
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
COC	Chemicals of Concern
COPC	Chemicals of Potential Concern
CPU	Clark Public Utilities
Cr VI	hexavalent chromium
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquids
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERL	Effects Range Low
ESD	Explanation of Significant Differences
Freon-11	trichlorofluoromethane
FS	feasibility study
gpm	gallons per minute
GW	ground water
HI	hazard index
HQ	hazard quotient
IWS	in-well stripping
LNAPL	light non-aqueous phase liquids
MCL	maximum contaminant level
MTCA	State of Washington's Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	polyaromatic hydrocarbon
PCE	tetrachloroethene or perchloroethene
PGG	Pacific Groundwater Group
POTW	Publicly Owned Treatment Works
ppb	parts per billion (or µg/L)
ppm	parts per million (or mg/kg)

ABBREVIATIONS AND ACRONYMS (Continued)

PQL	practical quantitation limit
PRB	permeable reactive barrier
PRG	preliminary remediation goal
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVOC	semivolatile organic compound
SWAPCA	Southwest Washington Air Pollution Control Agency
TBC	To Be Considered
TCA	trichloroethane
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TRV	toxicity reference value
UAO	Unilateral Administrative Order
USC	United States Code
USGS	U.S. Geological Service
WAC	Washington Administrative Code
VOC	volatile organic compound

Boomsnub/Airco Superfund Site
Record of Decision

DECISION SUMMARY

1.0 SITE DESCRIPTION

1.1 SITE NAME AND LOCATION

The Boomsnub/Airco Site ("the Site") is located north of Vancouver in unincorporated Hazel Dell, Washington (Figure 1-1). The Site is approximately two miles east of Interstate 5 and one mile west of Interstate 205, near NE 78th Street and NE 47th Avenue. The Site is bordered by a mixture of residential, commercial, and light industrial properties.

1.2 SITE DESCRIPTION

The Boomsnub property is approximately 0.75 acres and is located at 7608 NE 47th Avenue (Figure 1-2). The property is vacant except for a machine shop building unrelated to Site activities and the ground-water treatment system. The Boomsnub Corporation and its predecessor company, Pioneer Plating, conducted chrome plating operations at this location from 1967 until 1994, when Boomsnub moved its business to its current location at 3611 NE 68th Street.

The BOC Gases facility (formerly known as Airco) is an 11-acre, active gas production facility (Figure 1-1). It is located east of the Boomsnub property across the street from NE 47th Avenue at 4758 NE 78th Street. The company manufactures and distributes compressed and liquefied gas products including nitrogen, oxygen, and argon. The company also stores and distributes other gases such as hydrogen, acetylene, and helium. The BOC Gases plant has been in operation since 1964.

The Site also encompasses a plume of ground-water contamination that emanates from beneath the two facilities and extends in a west/northwest direction to NE 30th Avenue.

There are no known flood plains, endangered species, historical landmarks, or structures with historical significance identified at the Site. Seasonal wetlands have been identified along the south side of NE 78th Street just west of St. Johns Road, in the vicinity of extraction well MW-19D.

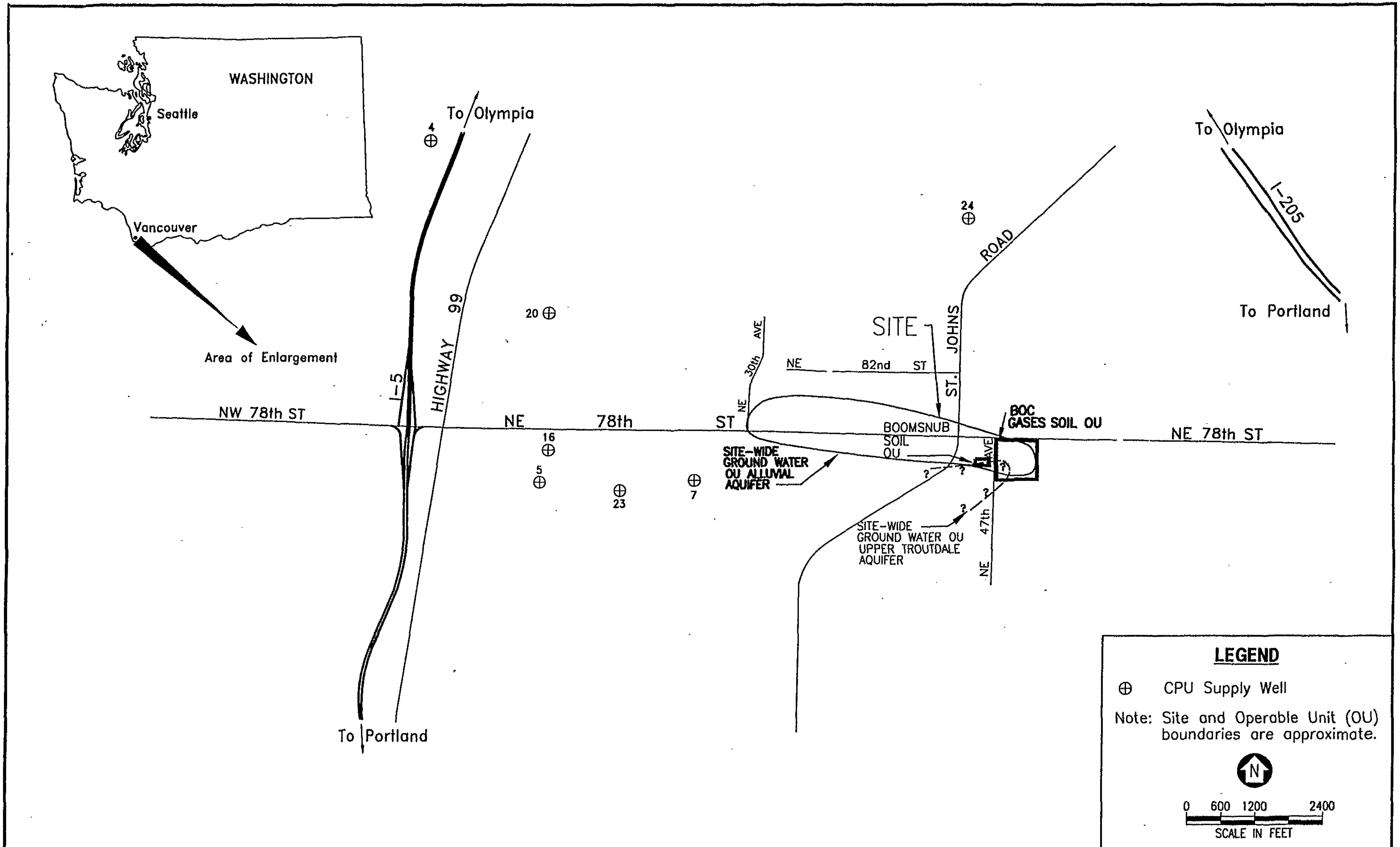

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Figure 1-1
Boomsnub/BOC Gases
Site Location Map

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, WA

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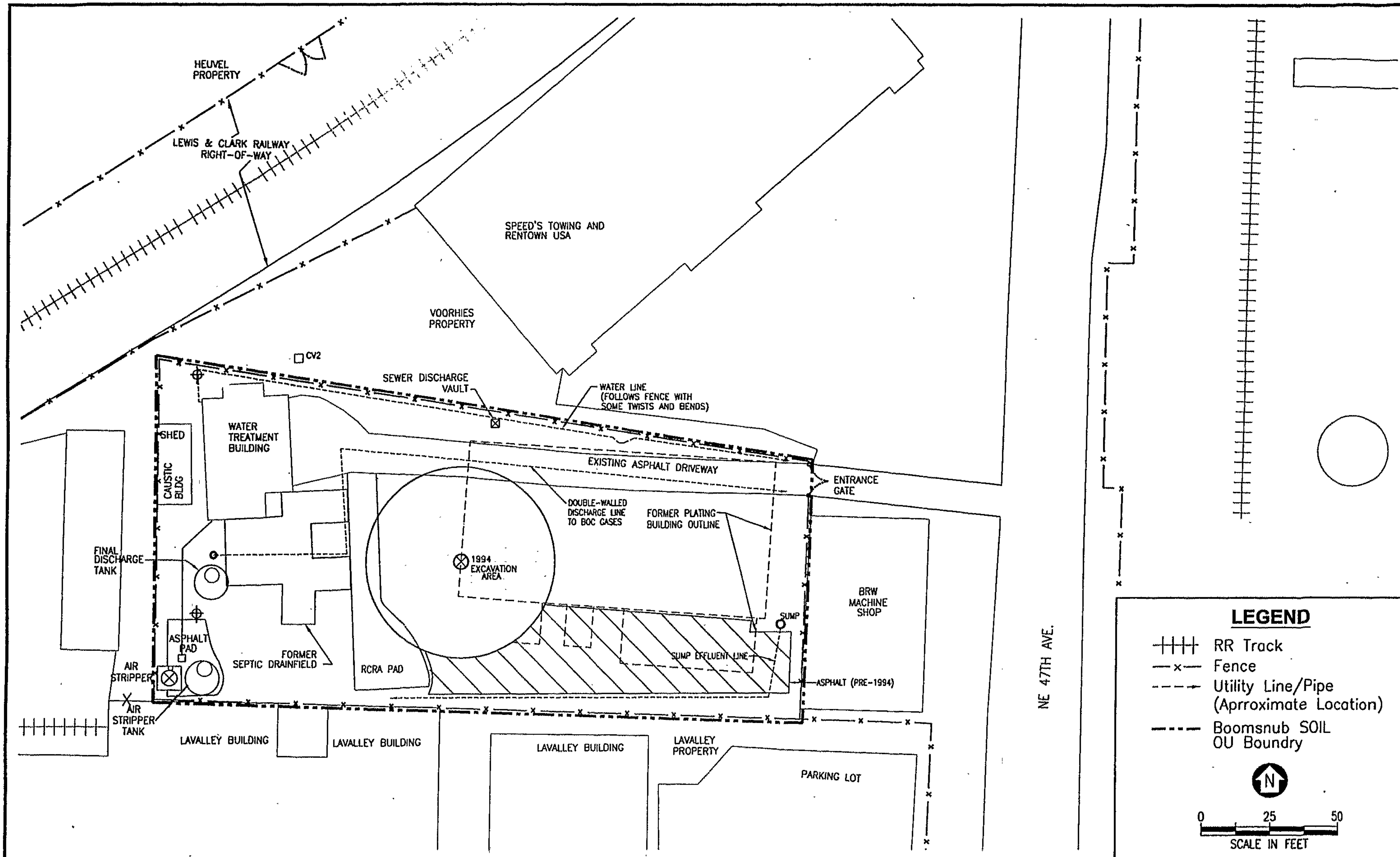

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Figure 1-2
Site Plan of the
Boomsnub Soil OU

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Boomsnub/Airco Superfund Site
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2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 BOOMSNUB CORPORATION

The Boomsnub Corporation has been in business since 1952. Pacific Northwest Plating, formerly known as Pioneer Plating Company, is a division of the Boomsnub Corporation. Pacific Northwest Plating operated an industrial hard chrome facility on the Boomsnub property from 1978 to 1994. Prior to 1978, the Pioneer Plating Company operated on the Site between 1967 and 1978. The electroplating process used by Boomsnub involved the use of a chromic acid solution containing hexavalent chromium. Available information indicates that chrome plating operations at the facility did not generate any RCRA-listed wastes.

2.1.1 State Enforcement Actions

In 1982, the Washington State Department of Ecology (Ecology) issued an Administrative Order to the Boomsnub Corporation. The Order required the corporation to line the vault underneath the plating tanks with an acid-proof coating to eliminate leaks and protect the concrete from corrosion. In response, the corporation installed a steel plate liner in the vault beneath the tanks.

In 1987, Ecology required the Boomsnub Corporation to install monitoring wells to detect the presence of chromium in the ground water that might have resulted from leaks, spills, and other practices over the years. Sampling results indicated levels of chromium in the soils and ground water at the facility in the thousands of parts per billion (ppb). In March 1990, Boomsnub reported to Ecology a significant (four orders of magnitude) increase in hexavalent chromium levels in one monitoring well at the Site. The company also stated that a break in its drinking water main released approximately 300,000 gallons of water to soil beneath the facility, which may have contributed to this increase. In May 1990, Ecology issued an enforcement order, pursuant to the State of Washington's Model Toxics Control Act (RCW 70.105D), to the Boomsnub Corporation. The order required the company to extract and treat chromium-contaminated ground water, monitor existing on-site wells, and conduct ground-water studies. Boomsnub installed pumping wells and began the extraction and treatment of ground water.

By August 1990, Boomsnub did not have the financial resources to meet the requirements of the Ecology order. Ecology assumed financial responsibility for operating the extraction/treatment system, expanding and upgrading the system installed by Boomsnub, and for monitoring ground water. These activities included upgrading the treatment system from reverse osmosis to ion exchange, and expanding the extraction network and treatment system to handle increased volumes of water. Ecology also constructed a pressure sewer line to the City of Vancouver's sanitary sewer system for the discharge of treated ground water. The Boomsnub Corporation provided some in-kind services, such as the treatment plant operator, however, Ecology paid for the majority of the Site work.

In 1993, Ecology requested that the U.S. Environmental Protection Agency (EPA) list the Site on the National Priorities List (NPL) because Ecology did not have the financial resources to continue cleanup at the Site. EPA proposed the Site for inclusion on the NPL on January 18, 1994. The Site was listed on the NPL on April 25, 1995 (60 Fed. Reg. 20330).

2.1.2 United States Criminal Proceedings

EPA conducted initial sampling of the Boomsnub property in conjunction with a criminal search warrant in April 1994. This sampling indicated that extremely high levels of chromium were present at the facility and in soil on the property. In 1995, a federal grand jury issued a criminal indictment against the Boomsnub

Corporation and three of its principal officers for illegal disposal and storage of hazardous waste. In late 1995, the U.S. Attorney entered into a plea agreement with the Boomsnub Corporation in which the company pleaded guilty to knowingly storing and disposing of hazardous waste without a Resource Conservation and Recovery Act (RCRA) permit, and knowingly violating the Clean Water Act by discharging waste water to the City of Vancouver sanitary sewer system without authorization. Two officers of the company pleaded guilty to one count each. The company was sentenced to five years probation and payment of restitution in the amount of $150,000, to be paid in equal amounts to EPA and Ecology. One officer of the company was sentenced to five years probation, home confinement, and payment of restitution in the amount of $60,000, in equal amounts to EPA and Ecology. The second officer received one year probation, and a fine of $1,000. Charges were not pursued against a third officer of the company due to his illness. The criminal settlement is independent of EPA's efforts to recover the Superfund money spent to investigate and clean up the chromium contamination at the Site from the Boomsnub Corporation and its officers.

2.1.3 EPA Enforcement Actions

In May 1994, EPA issued a Unilateral Administrative Order (UAO) to the Boomsnub Corporation and two officers of the company requiring the corporation to cease operations and provide EPA with access to perform response actions. The effective date of the UAO was temporarily extended for a short period during which the company attempted to abate the continuing release of chromium and to document that there were no continuing releases. This action was undertaken while the company was in the process of moving its operations to a new location. In June 1994, EPA's removal program took over lead-agency activities at the Site. The Boomsnub Corporation ceased operations at the Site shortly thereafter. The company reopened several months later at its current location at 3611 SE 68th Street.

EPA's removal operation included the off-site disposal of more than 400 drums of waste, demolition and removal of buildings and plating tanks, and removal and off-site disposal of 6,051 tons of chromium-contaminated soil. The removal action also included converting two monitoring wells (MW-25 and MW-26) to extraction wells and connecting them to the extraction network (Figure 2-1); increasing the pumping rate to 100 gallons per minute (gpm); and upgrading the ion exchange system to improve treatment efficiency and accommodate the increased extraction rate. EPA's Superfund remedial program took over operation of the extraction/treatment system from Ecology in January 1995.

2.2 BOC GASES

In 1991, during the course of the cleanup at Boomsnub, Ecology discovered volatile organic compounds (VOCs) in the ground water. The VOCs detected included trichloroethene (TCE), perchloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), and trichlorofluoromethane (Freon-11). Based on the concentrations and types of chemicals found in ground water, Ecology suspected BOC Gases as the source of the contamination. In August 1991, Ecology sent a letter to BOC Gases requesting that the company conduct an investigation. In response to this request, BOC Gases voluntarily conducted a two-phase investigation in 1992 that included subsurface soil borings and installation of monitoring wells along the perimeter of the property. Ground-water sampling results showed the presence of a variety of VOCs at various wells on the property.

2.2.1 State Enforcement Actions

In March 1993, BOC and Ecology signed an Agreed Order under the State of Washington's Model Toxics Control Act (MTCA) requiring BOC Gases to install additional ground-water monitoring wells, sample ground water, investigate potential sources of VOC contamination, and sample sediment and water in two on-site dry wells. Results of this investigation showed extremely high levels of TCE and Freon-11 (250,000 ppb and 800,000 ppb, respectively) in the sediment of the south dry well. An air stripper unit was added to the ground-water treatment system to treat VOCs.

In December 1993, Ecology issued an enforcement order requiring BOC Gases to install several off-site monitoring wells, further investigate potential sources of the VOC contamination on the BOC Gases property, and remove contaminated sediment from the south dry well. The Order also required BOC Gases to assume responsibility for operating the VOC portion of the extraction/treatment system. BOC complied with these requirements and has operated the air stripper for VOC treatment since 1994.

2.2.2 EPA Enforcement Actions

EPA and BOC Gases signed an Administrative Order on Consent (AOC) in January 1997 requiring BOC Gases to conduct a site evaluation at its facility. The purpose of the site evaluation, conducted in two phases, was to determine if a source (or sources) of VOC contamination remained in soil at the Site to warrant a removal action. This investigation is now complete. The results of the Phase I and Phase II Site Evaluation for the BOC Gases Soil OU are briefly described in Section 5.2.3 of this document.

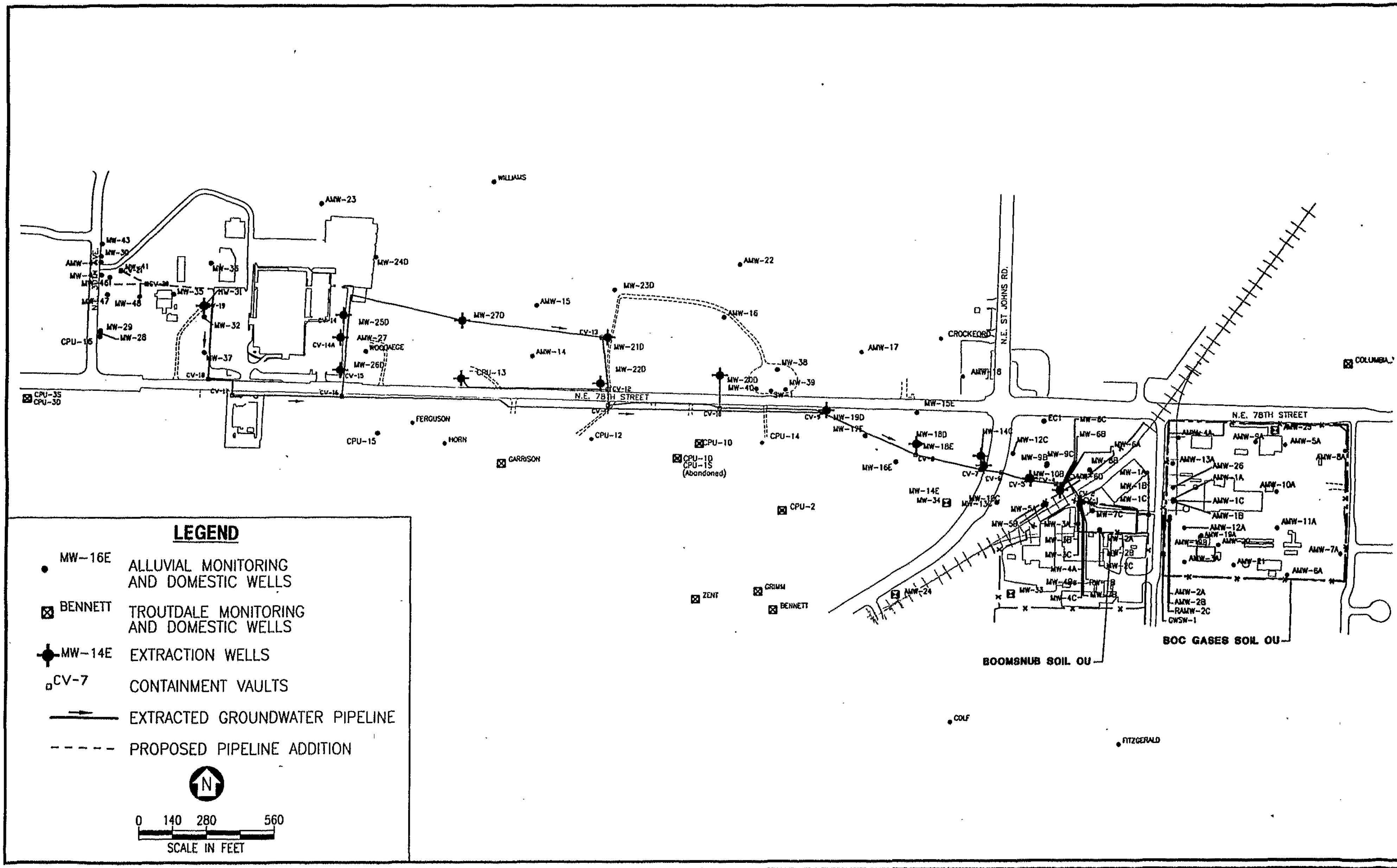

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Figure 2-1
Monitoring and Extraction Well Network - June 1999

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Boomsnub/Airco Superfund Site
Hazel Dell, WA

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3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

This section summarizes the community relations activities performed by EPA during the Remedial Investigation and Feasibility Study (RI/FS) during the period from February 1997 to September 7, 1999, when EPA's public comment period ended on this selected remedy. Earlier community relations efforts conducted by EPA and Ecology are summarized in the Interim Action Record of Decision (September 1997).

The RI/FS Report and Proposed Plan for the Boomsnub Site in Hazel Dell, Washington, were made available to the public on August 6, 1999. They can be found in the administrative record file at the information repository maintained at the EPA Region 10's Superfund Records Center in Seattle, Washington, and at the Vancouver Community Library in Vancouver, Washington.

The notice of availability of these documents was published in the *Vancouver Columbian* newspaper on August 8, 1999. A public comment period was held from August 6, 1999, to September 7, 1999. In addition, a public meeting was held on August 17, 1999, to present the Proposed Plan to interested members of the community. At this meeting, representatives from EPA answered questions about the Site and the cleanup alternatives. EPA also used this meeting to solicit oral comment on EPA's preferred alternative and to answer any questions from members of the public. EPA's response to the formal comments received during the public comment period is included in the Responsiveness Summary, which is Appendix A of this Record of Decision. Community involvement activities are summarized below:

- Fact Sheets. EPA maintains a mailing list of approximately 300 community members and interested parties who receive copies of all fact sheets generated by for this Site. Over the two and a half years that EPA conducted its investigations, seven fact sheets were mailed out providing updates on EPA's activities.

- Public Presentations. In addition to meetings with specific stakeholders, EPA held general public meetings to promote community involvement in EPA's activities.

  11/05/1998 — Presentation of Remedial Investigation findings to the Clark County Citizens Hazardous Waste Task Force (Task Force)

  04/22/1999 — Presentation of RI/FS findings to community members, hosted by the Task Force

- Media Coverage. In addition to EPA's community involvement activities, local newspaper and television media provided coverage of EPA's investigations, including:

  - *Vancouver Columbian* newspaper articles (print circulation 55,767)
    11/12/98 "Pollution Moving Toward Ground Water EPA Says"
    03/25/99 "EPA Digs in to Head Off Toxic Plume"
    08/13/99 "EPA Steps up Hazel Dell Ground Water Cleanup"
    08/18/99 "EPA's Plan for Cleanup of Pollution Applauded"

  - Local cable access channel 44 and KGW-TV Channel 8 Portland also provided local television coverage.

4.0 SCOPE AND ROLE OF OPERABLE UNIT

This Record of Decision (ROD) selects the final cleanup action for two of the three Operable Units (OUs) at this Site. The Boomsnub/Airco Superfund Site consists of two industrial facilities and a ground-water contaminant plume. Boomsnub is a chrome plating facility with historical spills of chromic acid that entered soils on their property and migrated to ground water. BOC Gases, located adjacent to the Boomsnub property, is an active compressed gases facility. Historical practices at the BOC Gases property have resulted in the presence of VOCs in soils and ground water. Releases of chromium and VOCs from the Boomsnub and BOC Gases properties, respectively, have resulted in a commingled plume extending approximately 4400 feet from the BOC Gases property line. EPA has divided this Site into three operable units to manage these cleanup activities.

4.1 BOOMSNUB SOIL OU

The Boomsnub Soil OU is located on the 0.75 acre parcel of the former Boomsnub facility at 7608 NE 47th Avenue. The existing ground-water treatment system is located on this OU. In 1994, 6,051 tons of contaminated soil was removed from this OU. Additional activities consisted of identifying the extent of chromium contamination and other hazardous substances remaining in soils on the Boomsnub property and adjacent properties subsequent to EPA's soil removal in 1994. Four surrounding properties were part of EPA's additional investigation:

- LaValley property line, adjacent to the southern boundary of Boomsnub
- Voorhies property, a triangular-shaped parcel adjacent to the north of Boomsnub
- Lewis & Clark Railroad right-of-way, northwest of Boomsnub and Voorhies properties
- Heuvel property, adjacent and northwest of the railroad right-of-way

Investigations at these properties focused on identifying the chromium remaining in soils because of its toxicity and mobility in soils and ground water. Other hazardous substances were tested for and identified in localized areas. As explained in Sections 5.0 and 6.0, other hazardous substances from the Boomsnub property represent low-level threats to human health and the environment.

4.2 BOC GASES SOIL OU

The BOC Gases Soil OU is located on the 11-acre BOC Gases facility at 4715 NE 78th Street. Investigations are complete for the BOC Gases Soil OU. Residual VOC contamination was found near the water table on the property. The scope of activities at the BOC Gases facility is now focused on a source control measure to prevent VOCs in ground water from continuing to migrate off the property. Based on the completed Phase I and II Site Evaluation, no soil removal will be required. The source control action for the BOC Gases Soil OU will be documented in an Action Memorandum by EPA. This selected remedy for the Site-Wide Ground Water OU assumes implementation of, and is compatible with, the alternatives being evaluated for source control at the BOC Gases Soil OU.

4.3 SITE-WIDE GROUND WATER OU

The Site-Wide Ground Water OU is roughly bounded by NE 51st Avenue on the east, NE 75th Street on the south, NE 30th Avenue on the west, and NE 81st Street on the north. The OU includes contaminated ground water beneath the Boomsnub and BOC Gases properties, as well as the area west/northwest where contaminated ground water has migrated into the Alluvial aquifer. The OU's vertical extent includes the Alluvial aquifer from ground surface to approximately 120 feet below ground surface. The OU also includes portions of the Upper Troutdale aquifer that have been impacted by Site contaminants. The areal extent of contamination is identified by chromium and TCE, which also represent the majority of risk at the Site. Other chemicals of concern in ground water, primarily other VOCs, are also addressed.

Under the Interim Action for the Site, EPA operates and maintains the ground-water extraction network, which grew from 15 wells in 1995 to 21 extraction wells currently. In June 1999, EPA was extracting water from 13 of the 21 extraction wells with a focus on preventing the spread of contaminants beyond NE 30th Avenue. EPA also operates and maintains the ion exchange system that removes the chromium from the ground water. BOC Gases operates the air stripping portion of the treatment system, which removes the VOCs from the ground water. After the water is treated, it is then discharged to the sanitary sewer, where it is further treated at the City of Vancouver waste water treatment plant. EPA samples the operating ground-water extraction wells on a quarterly basis. EPA also samples the influent and effluent from the treatment plant for compliance with its permit limits for discharge to the sanitary sewer. Twice a year, in the spring and fall, EPA samples selected wells in the ground-water monitoring network to determine the effectiveness of the cleanup.

5.0 SUMMARY OF SITE CHARACTERISTICS

The Site is located in an area of Clark County that has generally flat terrain with some rolling hills. The Site lies in the broad lowland basins between the Cascade Mountains to the east and the Coast Range to the west. The Columbia River, approximately two miles south of the Site, is the most prominent physiographic feature in the area. The Site lies in the broad historic flood plain of the Columbia River. Ground elevations at the Site range from approximately 250 to 290 feet above mean sea level (amsl).

5.1 GEOLOGY/HYDROGEOLOGY

The Soil Conservation Service identifies the surface soil in the central part of Clark County, including the Site, as a well-drained and medium-textured loam developed from Columbia River alluvium. A portion of the Site (west of NE St. Johns Road and south of NE 78th Street) is covered by poorly draining silt loam where standing water tends to accumulate in the winter months, creating a seasonal wetland. There are no wetlands on the Boomsnub or BOC Gases properties.

Although there are several surface water features in this area of Clark County, none of them is close enough to be impacted by the current extent of contamination. Vancouver Lake is a large lake that lies 3.5 miles west of the Site. Salmon Creek, the largest nearby creek, drains portions of Clark County flowing generally west approximately 2.5 miles north of the Site. Tributary streams to Salmon Creek that drain the area near the Site include Cougar Creek, Tenny Creek, and an unnamed intermittent stream, all of whose headwaters are located 1 to 1.5 miles north or northwest of the Boomsnub property, generally flowing away from the Site to the northwest. The Burnt Bridge/Salmon Creek drainage divide runs northeast across the Site, approximately 0.5 miles west of the BOC Gases property. Surface water to the north and west of the divide flows into Salmon Creek; water to the south and east of the divide flows into Burnt Bridge Creek via Cold Canyon. Both the BOC Gases and Boomsnub properties are located to the east of this surface water divide.

In the Hazel Dell area where the Site is located, unconsolidated sediment forms four principal hydrogeologic units: recent flood plain alluvium, Pleistocene Alluvial deposits (or "Alluvial aquifer"), the Upper Troutdale formation, and the Lower Troutdale formation. The two hydrogeologic units of concern at the Site are the Alluvial and Upper Troutdale aquifers. Pleistocene Alluvial deposits form the Alluvial aquifer from ground surface (approximately 280 feet amsl) to a depth varying from approximately 210 to 140 feet amsl at the Site. The Alluvial aquifer consists of highly permeable sandy sediments with interspersed silts and silt lenses. Because of its fluvial and alluvial origins, the formation has a great deal of natural heterogeneity. Regionally, the formation has low permeability and is, therefore, used only as a local supply aquifer. The water table in the Alluvial aquifer near the Site ranges from 10 to 30 feet below ground surface (bgs), with ground water flowing in a west/northwest direction.

A lower-permeability aquitard forms the bottom of the Alluvial aquifer, separating ground-water flow from the Alluvial and Upper Troutdale aquifers. Based on Site monitoring well data and soil borings, the aquitard consists of silts grading to clay and varies from 5 to 20 feet thick. The Upper Troutdale is a very prolific aquifer that is used for a regional drinking water supply. Ground water in the Upper Troutdale flows west/southwest, roughly parallel to St. Johns Road.

Estimates of horizontal ground-water flow rates vary depending on the method used to calculate the rate. Horizontal ground-water flow in the Alluvial aquifer is estimated at between 120 and 200 feet per year. Vertical ground-water flow rates also vary depending on the method used to calculate the rate. Using three separate methods, Pacific Groundwater Group, on behalf of Clark Public Utilities (CPU) previously estimated the vertical flow rate through the Alluvial aquifer at between 2 and 13 feet/year. These flow rates may vary over short distances due to the horizontal discontinuities in the thin low-permeability layers within the aquifer.

The Upper Troutdale aquifer lies beneath the Alluvial aquifer and consists of gravel and cobbles in a sandy matrix with variable amounts of silt. The formation varies from 100 to 300 feet thick. In the upper portion of the formation (above 85 feet amsl), the matrix has a higher silt and clay content. Directly below this exists an upper water-bearing zone that is generally about 30 feet thick. CPU water supply wells located in the vicinity of the Site withdraw water from this zone.

5.2 NATURE AND EXTENT OF CONTAMINATION

5.2.1 Conceptual Site Model

The primary concern at this Site is chromium and TCE migrating from the soil OUs to ground water, which has created a three-quarter-mile long (4,400 foot) ground-water plume in the Alluvial aquifer, 900 feet in width. Contamination in the Alluvial aquifer further threatens the CPU public drinking water supply wells located in the Upper Troutdale aquifer below. Without continued response actions, the ground-water plume will expand, impairing ground-water quality in both aquifers to a greater extent. A secondary concern is surface exposure to contaminants at the soil OUs. The Boomsnub Soil OU and contiguous properties are zoned for industrial use, so the nature and extent of contamination were evaluated to allow for continued industrial uses of the property in the future.

A number of mechanisms exist by which chemicals at the Site can migrate from contaminated soil at source areas to other areas and other media at the Site. Dissolved chemicals in soil generally migrate vertically in recharge and then migrate laterally within ground water under regional flow conditions. The primary release mechanism of concern at the Boomsnub Soil OU is from hexavalent chromium in soil leaching by infiltrating water during precipitation events. Soluble chemicals can then migrate vertically from soil to ground water. A secondary concern at the Boomsnub Soil OU is chemicals in surface soil, such as hexavalent chromium, that could be released to via wind-blown dust or other mechanical disturbances. Potential sources, release mechanisms, and receptors associated with chemicals detected in soil and ground water at the Site are summarized in Figure 5-1.

The chemicals of concern at the Site are hexavalent chromium and several VOCs in ground water and soil. The areal extent of chromium contamination in ground water (i.e., concentrations in excess of the Washington State MTCA B cleanup standard of 80 ppb) is estimated to be 37 acres. An overlapping 46 acres of land defines the areal extent of ground water impacted by TCE, with VOC contamination originating further east and extending further north than chromium. An estimated 60 million gallons of chromium-contaminated ground water and 75 million gallons of TCE-contaminated ground water need to be remediated. Table 5-1 identifies chemicals detected above ground-water cleanup standards during sampling conducted at the Site from 1995 to 1997. Actions have been taken at source areas for both the Boomsnub and BOC Gases Soil OUs. The excavation and removal of 10 drums of contaminated sediment from a dry well on BOC Gases property and removal of 6,051 tons of chromium-contaminated soil from the Boomsnub property removed most of the source material in soil. However, residual source material remaining at each OU serves as an ongoing source of contamination to ground water.

EPA's RI/FS was conducted to determine the extent of contamination remaining at the Boomsnub Soil OU and to supplement data on the Site-Wide Ground Water OU. The principal source of data for the Site-Wide Ground Water OU was obtained from eight biannual ground-water sampling events conducted from May 1995 to October 1998, as part of the operation and maintenance of the interim action pump and treat system. Additional monitoring data, geochemical data, and leachability data were also collected. Neither light non-aqueous phase liquids (LNAPL) nor dense non-aqueous phase liquids (DNAPL) were detected at the Site. A summary of the results of EPA's investigations is provided in the following sections.

5.2.2 Boomsnub Soil OU

As part of EPA's soil removal in 1994, a 70-foot diameter area was excavated to a depth of 28 feet, where the water table was encountered. Although this action removed the majority of contaminated soil, post-removal sampling indicates some chromium-contaminated soil remains on the property above the water table. Hexavalent chromium concentrations, measured at nearby monitoring wells beneath the Boomsnub property, have been significantly reduced from 1994 levels and generally appear to have stabilized. Despite the 1994 removal, concentrations remain above the 80 ppb ground-water cleanup standard (6,300 at MW4Bs, 360 ppb at MW2A, and 987 ppb at MW3A). EPA continues to extract ground water from a nearby extraction well (PW1B) in the northwest corner of the Boomsnub property to control the migration of hexavalent chromium from the Boomsnub property to the down gradient ground-water plume. Additional sampling was conducted during the RI/FS to determine the volume and areas of remaining chromium contamination in soil.

Approximately 300 surface and subsurface soil samples were collected and analyzed for total chromium during EPA's remedial investigation in 1997 and 1998. Thirty-two samples were analyzed for a full suite of contaminants (metals, cyanide, VOCs, SVOCs, pesticides, PCBs, and hexavalent chromium). The thirty-two samples were also analyzed to determine the percent of hexavalent chromium relative to total chromium in soils. Soil sampling locations are shown on Figure 5-2. Significant total chromium contamination remains at the Boomsnub property above the water table. Most of that contamination is located to the west of the previous removal effort, where an old septic drain field was located. Contamination in this area exists mostly between two and twelve feet deep. The maximum total chromium value detected (3,600 mg/kg) is located in the former septic area at three feet. By comparison, the maximum value of chromium detected below fifteen feet is 470 mg/kg, and most total chromium values below fifteen feet are less than 50 mg/kg. In addition, some limited surface contamination exists on properties immediately north (Voorhies property) and south (LaValley property line) of the Boomsnub property. The aerial extent of contamination is shown on Figure 5-3. In addition to chromium contamination, lead was also detected in two localized areas (Figure 5-4). Other contaminants were detected on the properties at low levels, including arsenic, polyaromatic hydrocarbons (PAHs), and semi-volatile organic contaminants (Table 5-2).

Three chromium leachability tests were conducted on Boomsnub Soil OU soil using the American Society for the Testing of Materials (ASTM) Method D-4874-95. The chromium leachability testing was conducted on two soil samples collected from the vadose zone and one in the saturated zone to evaluate the leaching potential of soil from three different Site conditions. First, a soil sample was collected near an infiltration gallery on the Boomsnub property and tested to determine whether using the infiltration gallery to dispose of treated ground water would mobilize chromium in soils. This first sample result suggested that future use of the infiltration gallery would reintroduce only minor quantities of chromium in soil to the ground water. The second chromium leachability test conducted on soil near the former plating building excavation suggested that rainfall percolation could continue to mobilize chromium contamination to ground water from higher chromium concentrations remaining in soil on the Boomsnub property. The third leachability test was conducted on saturated soil west of the infiltration gallery. The results of this test suggested that the leaching potential or tendency for aquifer soil to reintroduce dissolved chromium to ground water is minor though ground water may continue to be affected for an extended period by sorbed chromium from aquifer soil. These three results indicate that chromium contamination in soil at the Boomsnub property is likely to be an ongoing low-level source to ground-water contamination. Most of the remaining ongoing source of chromium to ground water is expected to come from an old septic field west of the 1994 soil removal, where the highest concentrations of chromium in soil are observed. In addition, TCLP testing was conducted during the RI on four samples. Three of the four samples exceeded the RCRA Land Disposal Restriction treatment standards for chromium based on TCLP total metals analysis. As a result, chromium-contaminated soils at the Boomsnub Soil OU are considered a characteristic hazardous waste under RCRA and would require disposal at a RCRA-approved landfill.

5.2.3 BOC Gases Soil OU

Under EPA's oversight, BOC Gases completed a Site Evaluation (Phase I and II) on its property (Figures 1-1 and 2-1) to identify any source of VOCs in the soil warranting a removal action. No widespread contamination that would justify a soil removal was detected at the property. However, there are lines of evidence suggesting a source of residual VOCs near the water table at the BOC Gases property. First, high concentrations of TCE (19,000 ppb) in ground water beneath the BOC Gases property were detected in 1997, correlating with a rise in the water table that year. Second, a soil vapor extraction pilot test near AMW-12A removed over two pounds of VOCs in a few hours. These data indicate the presence of residual VOC contamination in the subsurface, which may continue to release VOCs to the ground-water plume down gradient of the BOC Gases property.

The distribution of VOCs in subsurface soil and ground water in the vicinity of monitoring well AMW-12A suggests that the principal source of VOCs is located between a control room on the western portion of the BOC Gases property and AMW-12A, in the southwestern part of the property (Figure 2-1). The area of contamination covers approximately 7,000 square feet, with most VOCs detected at depths of 26 to 36 feet below ground surface in both the unsaturated and saturated zones. A second area of lesser ground-water contamination was identified in the northeast corner of the property extending slightly up gradient of BOC Gases' property line, but this localized area of contamination is not contributing to the larger ground-water plume.

5.3 SITE-WIDE GROUND WATER OU

Ground-water samples collected in 1989 from wells on the Boomsnub property showed chromium concentrations ranging from 1,300 to 5,800 ppb. During the following five years, from 1990 to 1994, ground-water concentrations from monitoring wells in the Alluvial aquifer peaked on the Boomsnub property at 2,400,000 ppb (at now abandoned well MW-11) and in the down gradient ground-water plume at 89,000 ppb (at MW-19D located in the field west of St. Johns Road). Sampling results from private wells and CPU monitoring wells during this period showed no chromium in the Upper Troutdale aquifer, but low concentrations of TCE were found in one private well and one CPU well. Ground-water samples from the same five-year period in wells in the Alluvial aquifer also showed a variety of VOCs including TCE at concentrations up to 9,200 ppb, 1,1,1-TCA at 390 ppb, PCE at 110 ppb, and Freon-11 at 220 ppb, correlating with contaminants detected in dry wells at the BOC Gases property. During the RI/FS several additional monitoring wells were installed and ground-water data from biannual sampling events and other sampling were evaluated to determine the current extent of ground-water contamination in both the Alluvial and Upper Troutdale aquifers.

The extent of ground-water contamination in the Alluvial aquifer is evaluated based on biannual sampling of Site wells from May 1995 to May 1998. Figure 5-5 provides a summary of the extent of ground-water contamination above remediation goals based on data from the May 1998 biannual sampling event. Both chromium- and VOC-contaminant plumes are generally within the same area in the Alluvial aquifers. Since the original release of contaminants occurred, the chromium-contaminant plume has migrated approximately 4,000 feet from the Boomsnub property in a west-northwest direction to NE 30th Avenue. The VOC-contaminant plume has migrated approximately 4,400 feet from the BOC Gases property in the same direction (the difference in plume length reflects the fact that the VOC source area is approximately 400 feet up gradient to the east of the chromium source area). The widest section of the plume measures roughly 900 feet. With the interim action pump and treat system, the plume is now being contained at NE 30th Avenue. Ground-water contamination in the Upper Troutdale is impacting ground-water quality in a localized area 1,500 feet extending southwest of the BOC Gases facility.

5.3.1 Chromium in the Alluvial Aquifer

Figure 5-6 presents chromium concentration contours based on data from the May 1998 biannual sampling event. If duplicate analyses were conducted on well samples, the highest concentrations detected are presented on the figure. Rejected data (flagged "R") are not included; however, estimated data (flagged "J") are included.

In May 1998, chromium was detected at concentrations between 1.1 ppb and 3.2 ppb in wells CPU-16, MW-28, MW-29, and MW-30, which are located on NE 30th Avenue approximately 4,000 feet west-northwest of the Boomsnub property. Chromium was detected at a concentration of 345 ppb in well MW-31, located approximately 400 feet up gradient. The highest concentrations of chromium were detected in wells MW-4B and MW-18D at 6,300 and 4,960 ppb, respectively. A comparison to the previous biannual sampling events indicates that the highest chromium concentrations were generally located farther up gradient (closer to the source location) than in previous years and, overall, the concentrations are decreasing over time.

The general trend interpolated from the data of historical chromium concentrations along the centerline of the plume is a decrease over time in chromium concentrations. It should be noted that pumping rates have generally increased since the treatment system was installed, which has presumably drawn both clean and contaminated water toward the extraction wells. This clean water may have lowered some of the recent chromium concentrations, which may make the declining trend appear more pronounced. However, the average concentration of chromium in monitored wells at the site in May 1998 was about 2,300 ppb, which still exceeds the federal drinking water standards for total chromium of 100 ppb and the Washington State MTCA B standard of 80 ppb for hexavalent chromium.

5.3.2 VOCs in the Alluvial Aquifer

The VOC-contaminant plume is located in the same general area within the Alluvial aquifer as the chromium-contaminant plume; the VOC plume, however, starts at the BOC Gases property and extends slightly farther to the north than the chromium plume. The VOCs most often detected are TCE, PCE, Freon-11, TCA, 1,1-DCE, and 1,1-dichloroethane (DCA). TCE has historically been detected at the highest concentrations and the occurrence of TCE typically defines the extent of VOC contamination in the Alluvial aquifer.

Figure 5-7 shows TCE concentrations throughout the monitoring and extraction network system from data collected during the May 1998 sampling event. The results show the maximum TCE concentration of 3,200 ppb in well AMW-12A, located on the BOC Gases property. The next highest concentrations of TCE were from wells MW-18E, MW-14C, and MW-1A, which all had TCE concentrations above 2,000 ppb. TCE was not detected above the laboratory-reporting limit in down gradient monitoring wells MW-28, MW-29, MW-30, and CPU-16 in the May 1998 sampling event. In May 1998, the average TCE concentration in monitoring wells was 590 ppb, which exceeds the federal drinking water standard for TCE of 5 ppb. Unlike chromium concentrations, which show a strong decreasing trend, the trend in TCE concentrations along the west-northwest centerline of the TCE plume is variable.

Discrete direct-push soil boring sampling was conducted in 1998 near MW-14E during the in-well treatability study. From the direct-push sampling, TCE was detected in ground water between 70 and 90 feet below ground surface (the deepest sample collected) at concentrations up to 3,300 ppb, and the highest concentrations were between 80 and 90 feet bgs. The reasons for this vertically segregated contamination are not known, but it may be caused by differing hydraulic flow pathways from each of the two source areas. While no evidence of DNAPL was found, the geoprobe data confirms that VOCs tend to be vertically restricted to this 20+ foot zone.

5.3.3 Ground-water Contamination in the Upper Troutdale Aquifer

Within the vicinity of the Site, the Upper Troutdale aquifer contains two productive zones located at approximately 190 and 280 feet bgs. CPU production wells 5, 7, 16, and 23 (Figure 1-1), which service the municipal and industrial customers in Hazel Dell and adjacent communities, are screened in the Upper Troutdale aquifer. The closest CPU production well to the Site area is well CPU-7, located approximately 1 mile due west of the Boomsnub property, south of the leading edge of the plume trajectory. Wells CPU-5, CPU-16, and CPU-23 are within one and a half miles of the Boomsnub property. Several wells (BOC Gases supply wells 1 and 2; monitoring wells MW-33, MW-34, AMW-24, AMW-25, CPU-1D (abandoned), CPU-2, CPU-3D, and CPU-10; and several private wells) are screened in the Upper Troutdale aquifer in the vicinity of the Site (Figure 2-1).

TCE was detected at a concentration of 0.5 ppb in monitoring well CPU-1D seven months after installation in July 1992. In May 1997, the TCE concentration increased to 11.2 ppb. CPU-1D was subsequently abandoned because of improper construction, which may have caused downward leakage within the wellbore from the Alluvial aquifer to the Upper Troutdale aquifer. Wells CPU-2 and CPU-10 were also analyzed for VOCs during the October 1997 sampling event; VOCs were not detected above reporting limits in either of these wells. TCE was detected in the Bennett domestic well at a concentration of 3.6 ppb in March 1997. VOCs have not been detected in the Zent or Garrison wells. VOCs were not detected in the BOC Gases' water supply wells in May 1993, or in January 1998. Well AMW-24, installed in the summer of 1997, had chromium at 5.2 ppb and TCE at 11.7 ppb in October 1997. It appears the Upper Troutdale aquifer has become impacted by site-related contamination to approximately 1,500 feet southwest. In early 1998, additional monitoring wells (i.e., MW-33 and MW-34) were installed; they were sampled in May 1998. Results of these and other recent data are described in the RI report, indicating low levels of contaminants similar to AMW-24 at MW-33.

Based on these concentrations, EPA's hypothesis is that an area of higher permeability exists in the aquitard in the vicinity of the Boomsnub and BOC Gases properties that has allowed low levels of contaminants observed in the Upper Troutdale to seep through the aquitard from the Alluvial aquifer above.

5.4 PRINCIPAL-THREAT AND LOW-LEVEL-THREAT WASTES

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430(a)(1)(iii)(A)). Principal-threat wastes are those "source materials" considered to be highly toxic or highly mobile that cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Low-level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. The statutory preference for treatment as a principal element is satisfied if the principal threat at the Site is addressed through treatment.

The principal threats posed by this Site are from hexavalent chromium in soils at the Boomsnub Soil OU and residual TCE at the soil/ground water interface at the BOC Gases Soil OU. Previous removal and enforcement actions taken at the Site have already addressed most of the principal-threat source material at each of the Soil OUs. However, RI/FS investigations identified some hexavalent chromium and VOC contamination still present in soil at the Boomsnub Soil OU and BOC Gases Soil OU, respectively. This contamination is considered a principal threat due to contaminant mobility from soil to ground water and toxicity in ground water for both hexavalent chromium and VOCs.

Specifically, higher chromium concentrations in the former septic tank area are a principal threat at the Boomsnub Soil OU due to the potential for chromium to leach to ground water. Lead in soils at the Boomsnub Soil OU is considered a low-level threat because it is less mobile, appears in very localized areas and therefore presents lower risks to potential future workers at the Site.

At the BOC Gases Soil OU, VOCs are present as vapor in pore spaces and as residual contamination (principally TCE) sorbed to subsurface soil near the water table. VOCs present near the water table may be considered a principal threat due to the mobility of VOCs in high concentrations to migrate down gradient in ground water. VOCs at the BOC Gases property will be addressed through source control actions determined in a separate EPA Action Memorandum.

By definition, there are no principal threats associated with the Site-Wide Ground Water OU because ground water contamination is generally not considered a source material, and therefore would not be characterized as a principal threat. However, chromium and VOC contamination in ground water constitutes the primary risk remaining at the Site and is the current focus of EPA's actions.

5.5 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

5.5.1 Land Uses

The Site-Wide Ground Water OU comprises various parcels of land zoned for commercial, light industrial, and residential uses, with large tracts of land currently undeveloped. The Boomsnub Soil OU and parcels immediately adjacent to it are zoned for light industrial use and are expected to remain industrial use. Long-term businesses in the immediate area include Permalume Plastics (currently inactive), GL&V LaValley (fiberglass tank manufacturer), Electroheavy (electrical motor shop), and a Shell gas station. The BOC Gases Soil OU is zoned for light industrial use, but is also located nearer a residential development that borders the southwest corner of the property boundary.

5.5.2 Ground Water Uses

Several private wells associated with individual residences have been identified in both the Alluvial and Upper Troutdale aquifers in the vicinity of the Site (Figure 2-1). None of the private wells within the area of ground-water contamination are currently being used for drinking water, although some private wells may be used for garden or lawn irrigation and other domestic uses. The majority of residents are currently connected to Clark County municipal water system. All new residential developments would also likely be connected to a municipal water supply, but individuals with water rights may want to use ground water for domestic purposes in the future.

CPU owns drinking water supply wells located in the Upper Troutdale aquifer; these wells serve approximately 65,000 residents. The nearest CPU well to the site is CPU-7, located approximately one mile west of the Boomsnub property, and 2,000 feet southwest of contamination in the Alluvial aquifer. CPU-7 is currently used only to meet peak summer demands because of concern that ground-water contamination from the Alluvial aquifer at the Site could migrate to the Upper Troutdale aquifer below where the municipal wells are located.

Table 5-1
Occurrence and Distribution of Chemicals in Ground Water[1]
Boomsnub/Airco Superfund Site, Site-Wide Ground Water Operable Unit

Chemical	Minimum Conc. (µg/L)	Maximum Conc. (µg/L)	Location of Maximum Conc.	Detection Frequency	Background Value	Criteria	Basis for Criteria
Arsenic (Unfiltered)	0.24	5.95	AMW-9A	238/341	<1 - 4 (i)	0.0583	MTCA B
Beryllium (Unfiltered)	0.007 J	4.7	AMW-14	9/341	<0.5 (i)	0.0203	MTCA B
Cadmium (Unfiltered)	0.04	10.3	MW-9C	56/341	<1 (i)	8	MTCA B
Chromium (Unfiltered)	1.5	51,000	MW-20D	464/588	5 (ii)	100	MCL
Chromium, Hexavalent (Unfiltered)	778 J	37,500 J	MW-20D	46/46	NA	80	MTCA B
Manganese (Unfiltered)	1	7,080	AMW-9A	269/341	3 (ii)	2,240	MTCA B
Nickel (Unfiltered)	14 J	1,090	MW-6C	10/341	<1 - 4 (i)	100	MCL
Bromodichloromethane	0.15 J	14.2 J	MW-15E	17/437	NA	0.706	MTCA B
Carbon Tetrachloride	0.12 J	23.8	MW-1A	25/437	NA	0.337	MTCA B
Chloroform	0.11 J	6.8	AMW-12A	166/437	NA	7.17	MTCA B
1,2-Dibromo-3-Chloropropane	1 J	1 J	MW-13C	1/391	NA	0.0313	MTCA B
Dibromochloromethane	0.12 J	2.6	MW-5B	9/437	NA	0.521	MTCA B
1,2-Dichloroethane	0.16 J	18.6 J	AMW-12A DUP	57/437	NA	0.481	MTCA B
1,1-Dichloroethene	0.18 J	352.7	MW-14E	249/437	NA	0.0729	MTCA B
Cis-1,2-Dichloroethene	0.034 J	78.6 J	AMW-12A DUP	176/328	NA	70	MCL
Fluorotrichloromethane	0.34 J	2,910	AMW-1A	194/390	NA	2,400	MTCA B
Hexachlorobutadiene	2 J	2 J	MW-13C	1/391	NA	0.561	MTCA B
Methylene Chloride	0.27 J	13.6 J	MW-18D	3/436	NA	5.83	MTCA B
1,1,2,2-Tetrachloroethane	5 J	5 J	MW-27D	1/437	NA	0.219	MTCA B
Tetrachloroethene	0.059 J	254	MW-14E	464/637	NA	5	MCL
1,1,1-Trichloroethane	0.16 J	1,110	AMW-12A	317/437	NA	200	MCL
Trichloroethene	0.14 J	19,300 J	AMW-12A	559/637	NA	5	MCL
Vinyl Chloride	0.55 J	1.4 J	MW-1A	3/437	NA	0.023	MTCA B

[1]Ground water all wells (1995 - 1997)

(i) Background values derived from (USGS, 1998) *Quality of Ground Water in Clark County, Washington.*
(ii) Background values derived from local background well (AMW-7A).

Table 5-1 (Continued)
Occurrence and Distribution of Chemicals in Ground Water[1]
Boomsnub/Airco Superfund Site, Site-Wide Ground Water Operable Unit

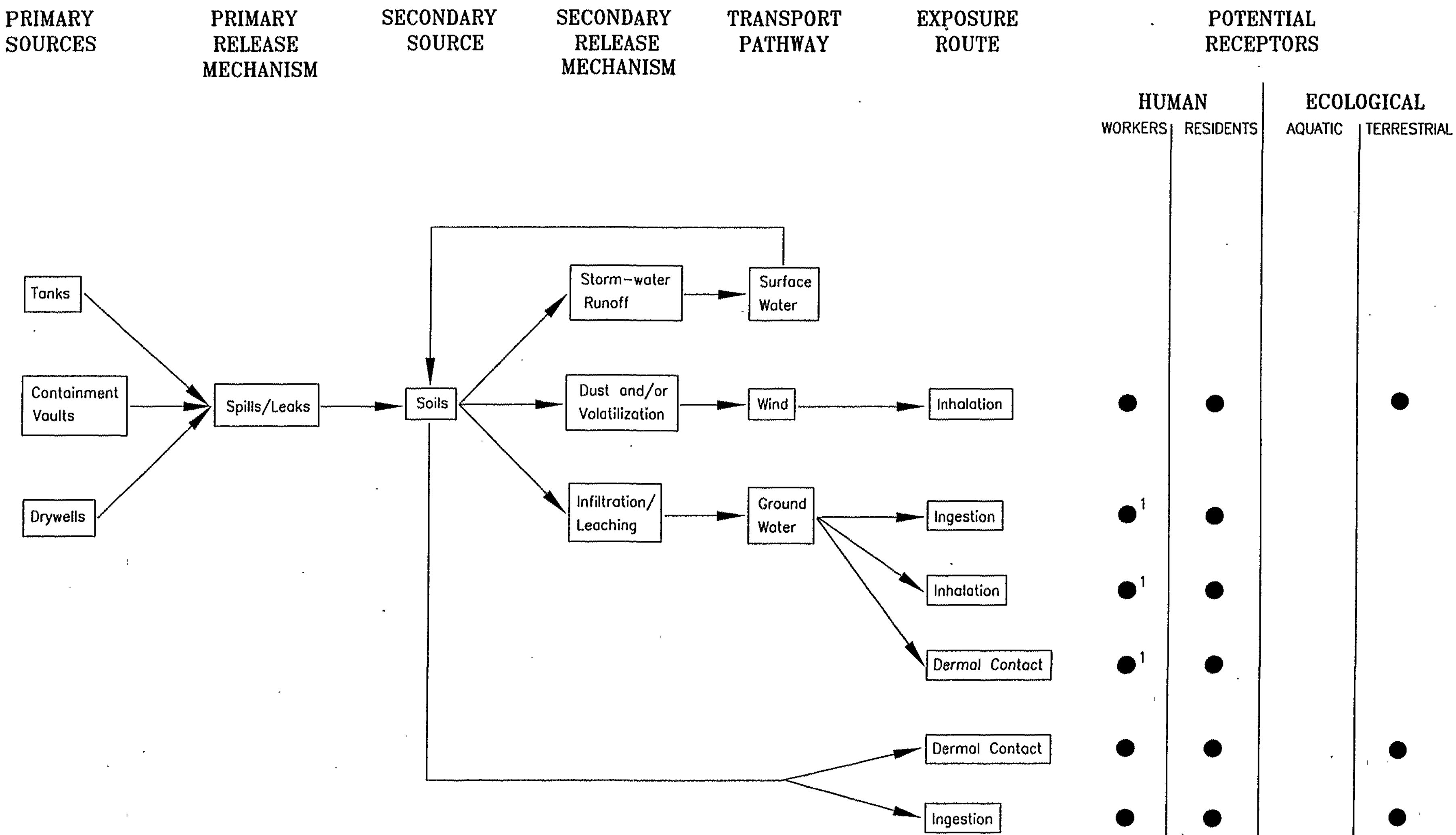
J = estimated data
MCL = maximum contaminant level
MTCA = Washington State's Model Toxics Control Act
NA = not applicable
µg/L = micrograms per liter or parts per billion (ppb)

Table 5-2
Soil Exceedances Associated With the Industrial Land Use Scenario
Boomsnub Soil OU

Analytes	Maximum Detection Soil[1] (mg/kg)	Industrial Scenario Criteria (mg/kg)	Basis for Criteria	Exceedances Above Soil Criteria[4]
Arsenic	32.3	219	MTCA C Industrial	0
Chromium (total)	2,090	--	MTCA 100x Ground-water Std.[2]	--
Chromium VI	410	8	MTCA 100x Ground-water Std.[2]	12
Chromium III	2,000	1,600	MTCA 100x Ground-water Std.[2]	2
Lead	2,580	1,000[3]	MTCA A Industrial	4
Benzo(a)anthracene	1.5	18	MTCA C Industrial	0
Benzo(b)fluoranthene	1.8	18	MTCA C Industrial	0
Benzo(k)fluoranthene	1.6	18	MTCA C Industrial	0
Benzo(a)pyrene	1.5	18	MTCA C Industrial	0
Chrysene	1.7	18	MTCA C Industrial	0
Dibenz(a,h)anthracene	0.081	18	MTCA C Industrial	0
Indeno(1,2,3-cd)pyrene	1.6	18	MTCA C Industrial	0

[1]Maximum soil concentrations from Tables 4-3 and 4-5 of the RI.
[2]Soil cleanup level represents 100 times the MTCA ground-water cleanup level reported in the Ecology CLARCII database dated 2/28/96.
[3]MTCA Method A Industrial value shown for lead (no Method C Industrial value exists for lead).
[4]Out of a total of 32 samples (including 2 duplicates) analyzed for the full target analyte list during the RI

mg/kg - milligrams per kilogram or ppm.



1 – Workers are potential receptors for ground-water exposure; however, this potential exposure was not quantified because the potential exposures are expected to be less than for the residential receptors.

EPA REGION 10	**Figure 5-1** **Conceptual Site Model**	RECORD OF DECISION Boomsnub/Airco Superfund Site Hazel Dell, WA

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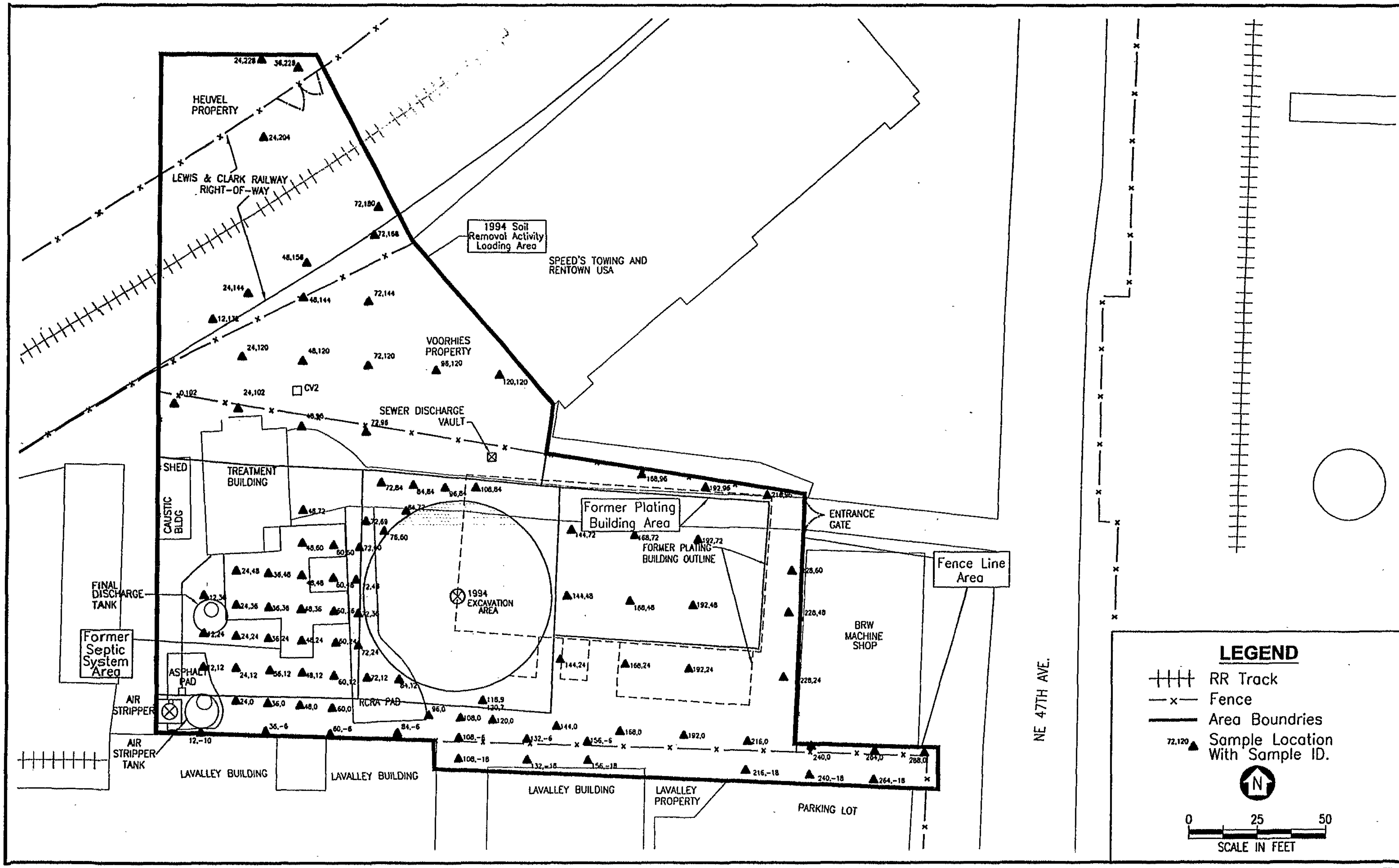

EPA REGION 10

Figure 5-2
Sample Area and Locations at the Boomsnub Soil OU

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, WA

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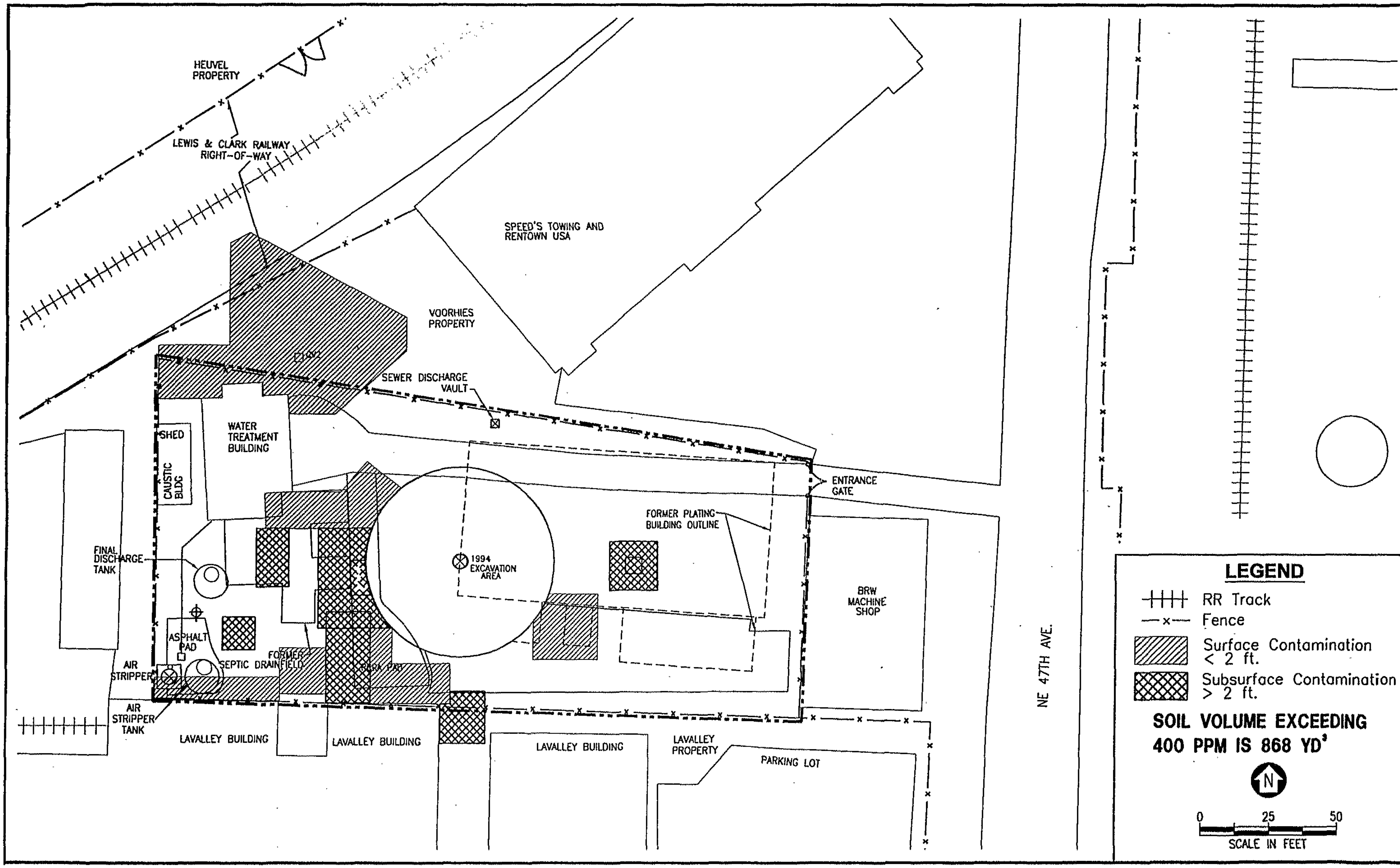

EPA REGION 10

Figure 5-3
Boomsnub Soil OU
Areas With Chromium in Soil
Exceeding 400 PPM

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, WA

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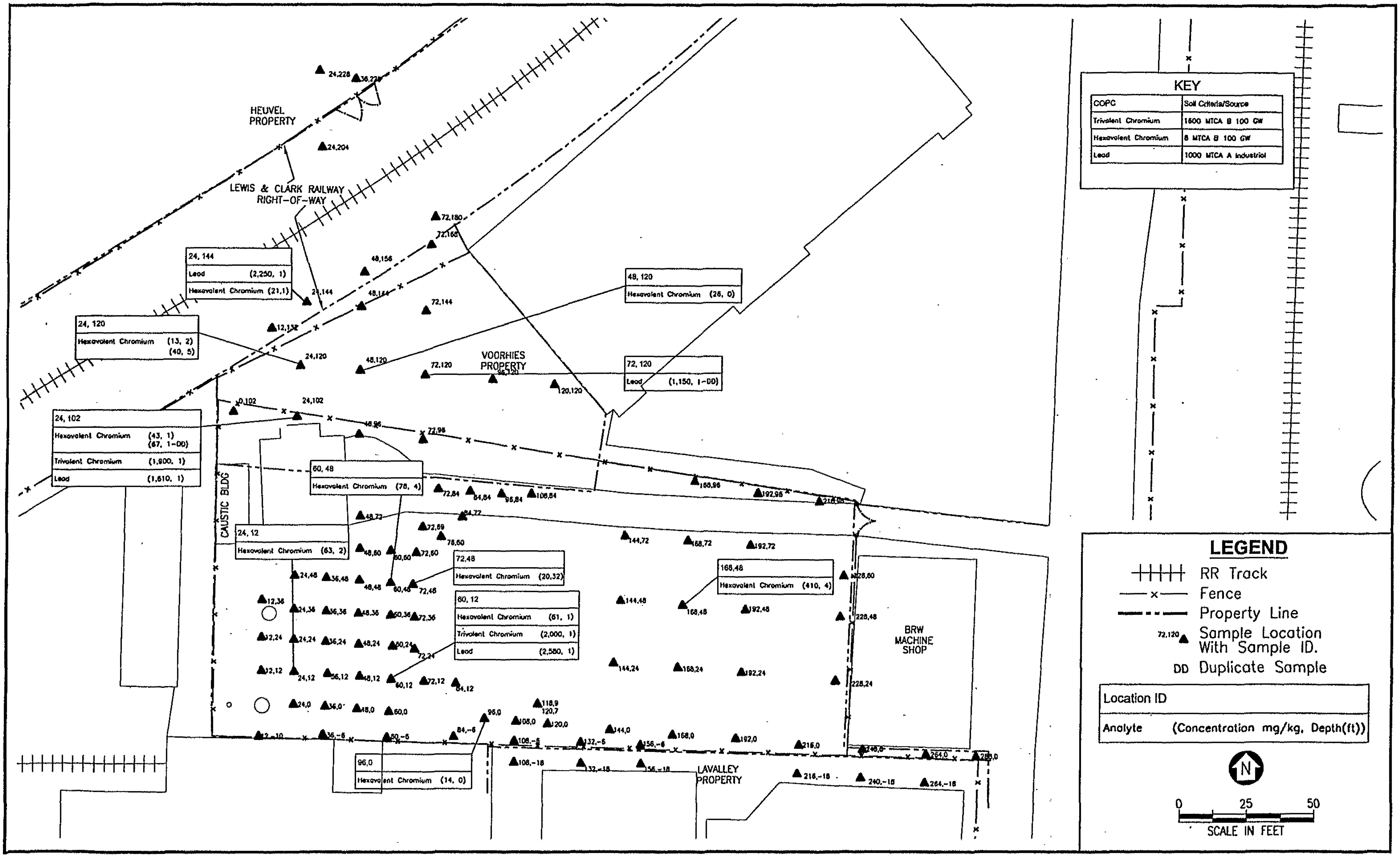

EPA REGION 10

Figure 5-4
Extent of Soil Exceedances Using Industrial Land Use Scenario

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, Wa

FILENAME: T:\RAC\Boomsnub\Sub-Tasks\ROD\R-6.dwg
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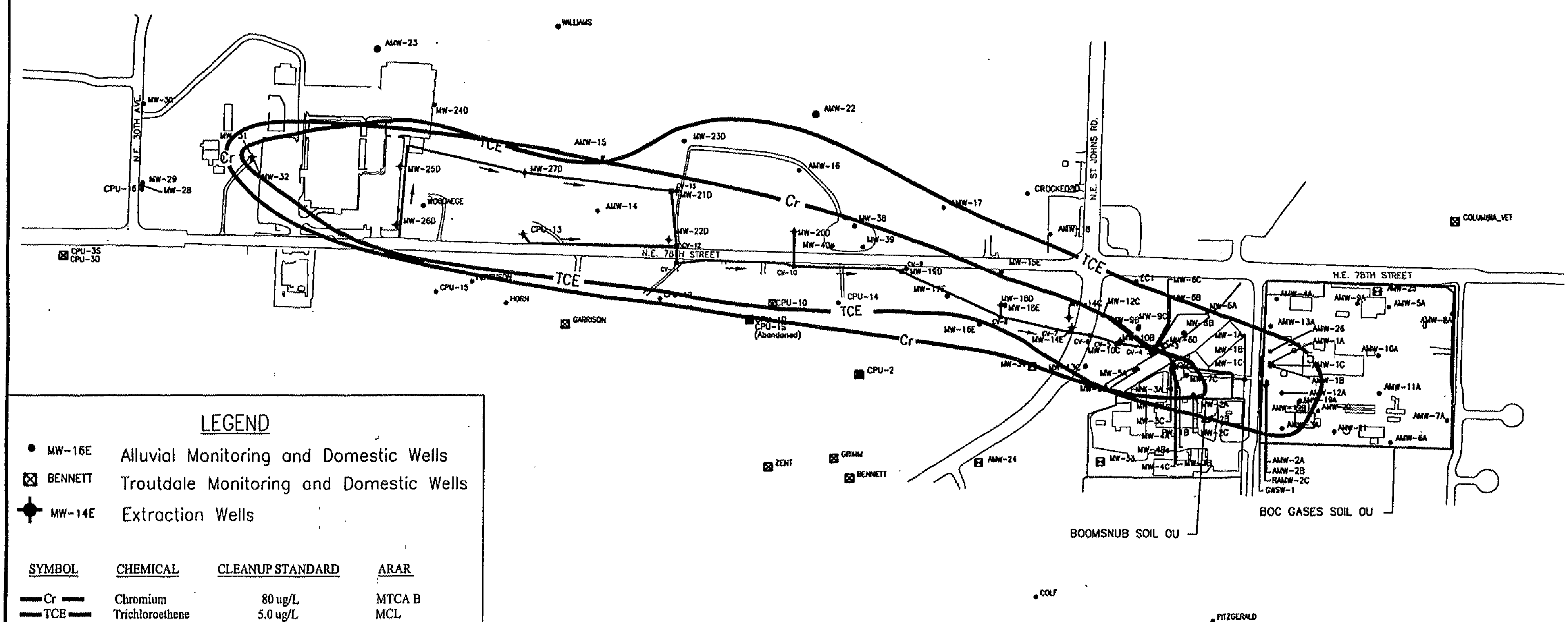


LEGEND

- MW-16E — Alluvial Monitoring and Domestic Wells
- BENNETT — Troutdale Monitoring and Domestic Wells
- MW-14E — Extraction Wells

SYMBOL	CHEMICAL	CLEANUP STANDARD	ARAR
Cr	Chromium	80 ug/L	MTCA B
TCE	Trichloroethene	5.0 ug/L	MCL

NOTES

ARAR: Applicable or Relevant and Appropriate (regulatory basis for clean up standard)
MTCA B: Cleanup standard based on Washington Department of Ecology Model Toxics Control Act, WAC 173-340-720
ug/L: micrograms per liter or parts per billion
MCL: Maximum Contaminant Level

N

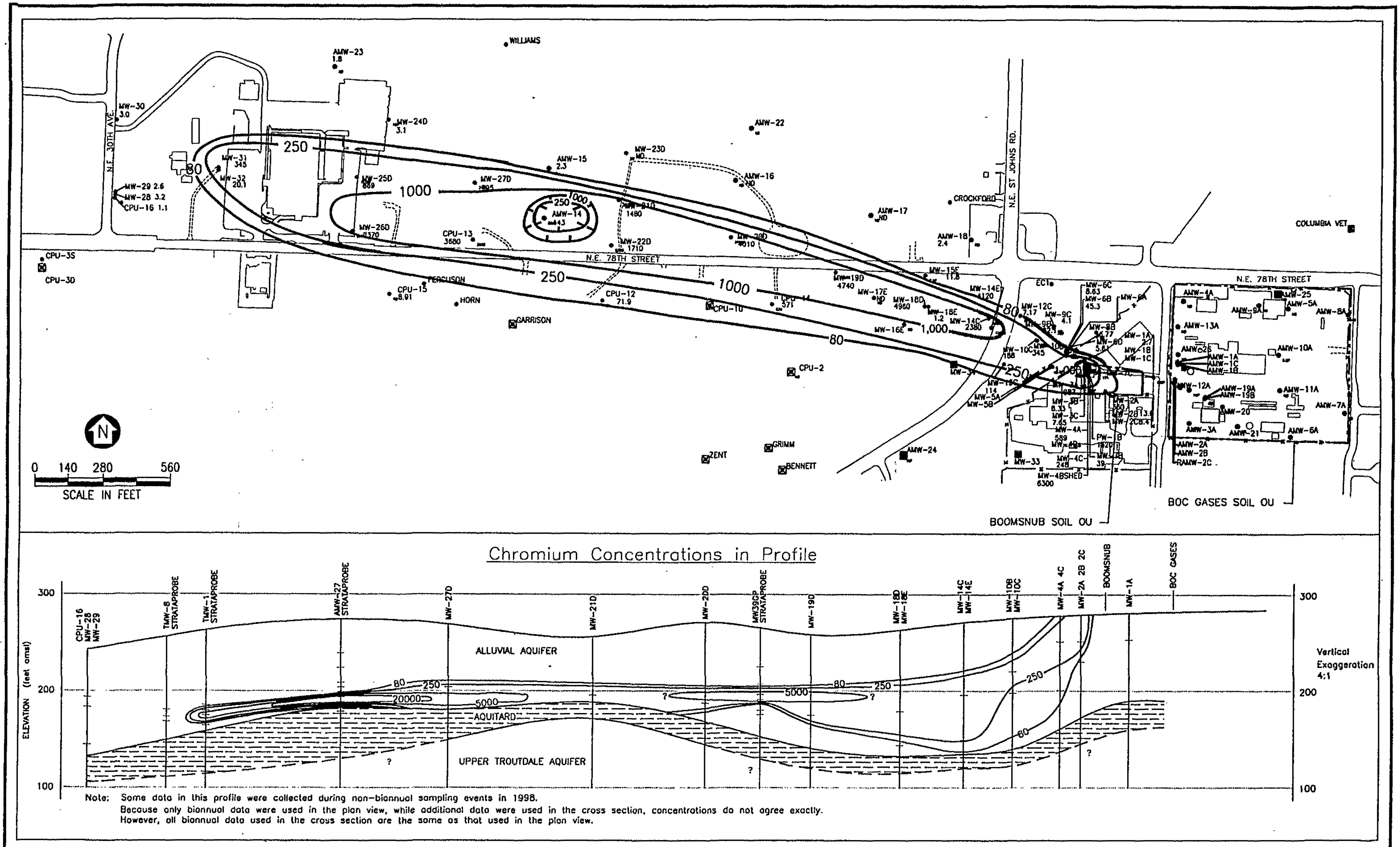
0 150 300 600
SCALE IN FEET

EPA
REGION 10

Figure 5-5
Extent of Contamination Exceeding Ground-Water Cleanup Standards
May 1998

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, WA

FILENAME: T:\RAC\Boomsnub\Sub-Tasks\ROD\R-9.dwg
EDIT DATE: 09/28/99 AT: 14:58

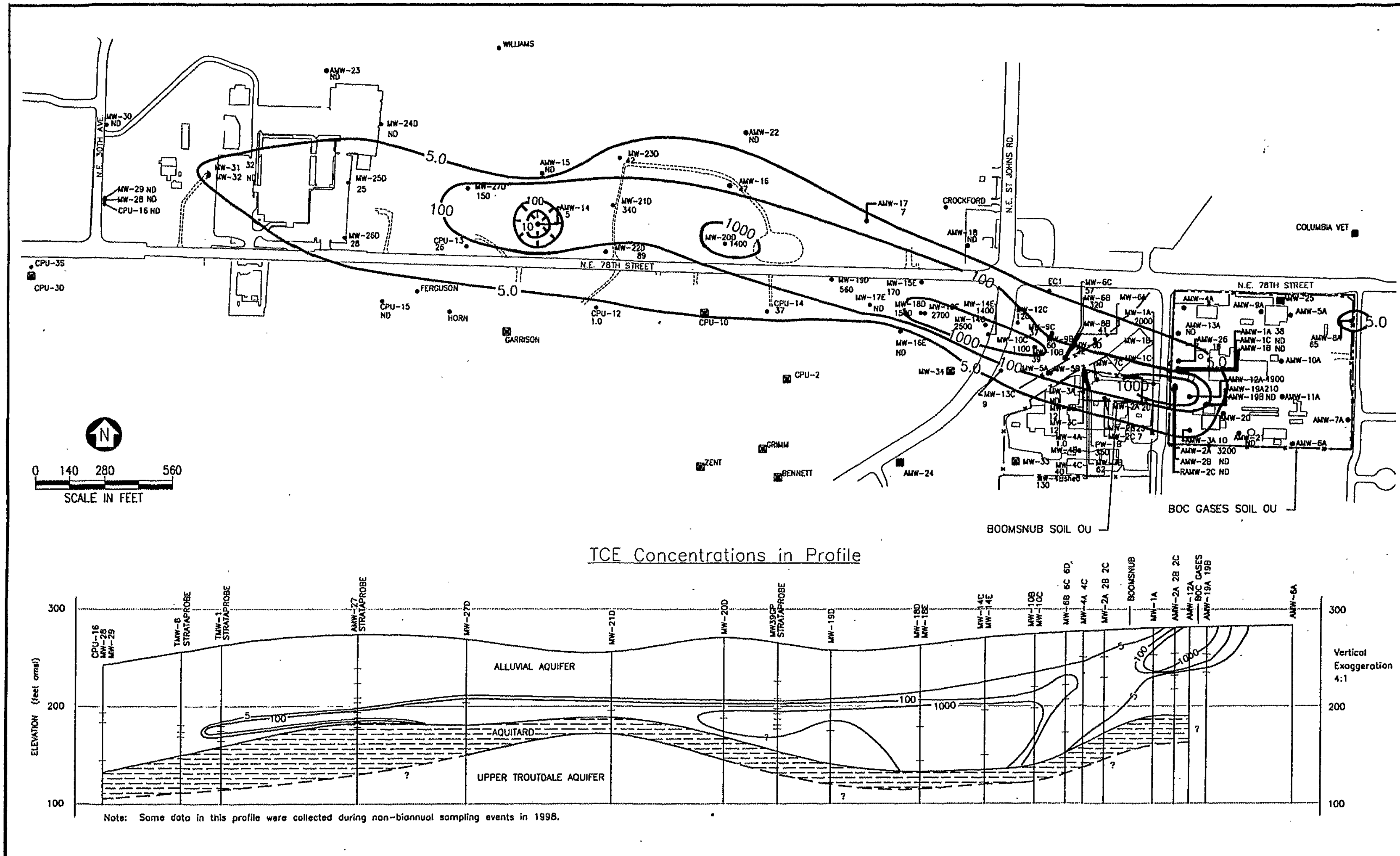


EPA
REGION 10

Figure 5-6
Chromium Concentrations (ppb) in the Alluvial Aquifer
May 1998

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, WA

FILENAME: T:\RAC\Boomsnub\Sub-Tasks\ROD\R-8.dwg
EDIT DATE: 09/28/99 AT: 15:00



EPA REGION 10	**Figure 5-7** **Trichloroethene Concentrations (ppb) in the Alluvial Aquifer** **May 1998**	RECORD OF DECISION Boomsnub/Airco Superfund Site Hazel Dell, WA

FILENAME: T:\RAC\Boomsnub\Sub-Tasks\ROD\R-7.dwg
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6.0 SUMMARY OF SITE RISKS

The baseline risk assessment estimated risks posed by the Site if no action is taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by remedial action. This section summarizes the results of the baseline risk assessment for the Boomsnub Soil OU and the Site-Wide Ground Water OU, which included a human health risk assessment and an ecological risk assessment. A risk assessment for the BOC Gases Soil OU was conducted separately as part of the Site Evaluation.

6.1 HUMAN HEALTH RISK ASSESSMENT

The baseline risk assessment evaluated the potential current and future effects of contaminants on human health and the environment. The baseline risk assessment for the Boomsnub Soil OU focused on health effects for adult workers at the Site. The baseline risk assessment for the Site-Wide Ground Water OU focused on health effects for both children and adults who might drink contaminated ground water used as a domestic water supply. Because of previous efforts to provide municipal water supply connections to residents in the immediate vicinity of the ground-water plume, no one is currently being exposed to contaminated ground water at levels above health concerns. However, EPA evaluated the potential risk to future residents if EPA did not continue cleanup of the Site. Four separate steps in the risk assessment process were conducted:

- Evaluation of data and identification of chemicals of concern (COCs),
- Identification and quantification of COC toxicity,
- Identification of exposure pathways and potential human receptors, and
- Characterization of potential human health risks to current and future receptors.

6.1.1 Data Evaluation and Identification of Chemicals of Concern

Ground-water and soil samples that were collected and analyzed during the RI and other investigations were used in the risk assessment. Chemical concentrations detected in samples were compared to background levels and risk-based screening concentrations. Chemicals of potential concern (COPCs) for soil and ground water were identified if their maximum detected concentration in any sample was greater than EPA Region 9 Preliminary Remediation Goals or the State of Washington's MTCA Method B residential cleanup standards. A number of metals and organic compounds were identified as COPCs and were carried through subsequent steps of the risk assessment.

Appendix B presents the exposure point concentration for each of the COCs detected in soil and ground water (i.e., the concentration used to estimate the exposure and risk from each COC in the soil and/or ground water) and how it was derived. Due to the limited amount of sample data available for soil, the maximum concentrations were used as the default exposure point concentrations for each property. For ground water, EPA used biannual ground-water data collected from May 1995 to October 1997. The more recent 1997 data was used in calculating exposure point concentrations.

The baseline risk assessment identified 27 COPCs for ground water and 10 COPCs for the Boomsnub Soil OU. This list of ground-water COPCs was further reduced by EPA subsequent to the FS eliminating contaminants that were either below background concentrations or were not detected above ground-water cleanup levels during the 1997 biannual sampling round. This resulted in the list of soil and ground-water COCs that are shown in Section 7.0, Tables 7-1 and 7-2.

6.1.2 Exposure Assessment

An exposure assessment was conducted to characterize the Site OUs, identify exposure pathways and potential receptors, and quantify exposure pathways. Future land use for the Boomsnub Soil OU will most likely be similar to current conditions and will probably remain industrial. Industrial workers are the most likely potential future receptors who could be exposed to contaminants in soil. However, future uses of the other portions of the Site and surrounding areas could differ considerably from current uses. Hypothetical future uses might include the development of all or portions of the Boomsnub Soil OU for residential purposes. To be protective of human health and the environment, it was conservatively assumed for the human health risk assessment that the future land use of the Boomsnub Soil OU may be residential. For this reason, both industrial and residential exposure scenarios were evaluated. In addition, the Site-Wide Ground Water OU was evaluated assuming residential use. The following potentially complete exposure pathways were identified for the Site OUs:

- Incidental ingestion and dermal absorption of chemicals in on-site surface soil by future residents and industrial/commercial workers (Boomsnub Soil OU).
- Inhalation of fugitive dust from on-site surface soil by future residents and industrial/commercial workers (Boomsnub Soil OU).
- Ingestion and dermal contact of chemicals in ground water by future residents from tap water use (Site-Wide Ground Water OU).
- Inhalation of VOCs in ground water from tap water use by future residents (Site-Wide Ground Water OU).

These pathways are summarized in the site conceptual model in Figure 5-1.

6.1.3 Toxicity Assessment

Toxicity assessment is the process of characterizing the relationship between the dose of a chemical and the anticipated incidence of an adverse health effect. A toxicity assessment presents available toxicity criteria developed by EPA for evaluation of the potential risks from exposure to toxic chemicals.

For risk assessment purposes, chemical effects are separated into two categories of toxicity: noncarcinogenic effects and carcinogenic effects. Cancer and noncancer toxicity data for the oral/dermal and inhalation pathways in soil and ground water are not summarized here but are presented in the baseline risk assessment.

6.1.4 Risk Characterization

Risk characterization is defined as the nature and magnitude of potential human health risks, including their inherent uncertainty. Sites posing a cumulative lifetime excess cancer risk of 1×10^{-4} (1 in 10,000) or less may not pose an unacceptable risk and may not require remedial activities. Under most situations, cancer risks in the range of 1×10^{-4} to 1×10^{-6} and non-cancer hazard indices (HIs) of one or less are considered to be acceptable, depending on site-specific conditions. In certain cases, EPA may consider risk estimates slightly greater than 1×10^{-4} and HIs slightly above one (1) to be protective. Based on the State of Washington MTCA for sites involving multiple chemicals and multiple pathways of exposures, the total excess lifetime cancer risk shall not exceed 1×10^{-5} (1 in 100,000) and the HI shall not exceed one (1). Under state regulations, risks above this range are generally considered unacceptable, in which case remediation may be required.

6.1.5 Human Health Risk Assessment Conclusions

Overall, risks from hexavalent chromium and several VOCs in ground water at the Site-Wide Ground Water OU exceed acceptable risk levels based on conservative risk assumptions. Of the 27 ground-water COPCs identified in the baseline risk assessment, three contaminants: TCE, 1,1-dichloroethene, and hexavalent chromium, account for most of the risk to residents from use of contaminated ground water as a domestic water source. Human health risks were evaluated for both cancer and non-cancer risks. The risks are discussed in ranges because the contaminant levels are higher in some parts of the Site and lower in others. For wells evaluated in this risk assessment, chromium and TCE account for 96% of the non-cancer risks at the Site. TCE and 1,1-DCE account for 85% of the excess cancer risk at the Site, while the remaining VOCs comprise the remainder of the risk.

<u>Cancer Risks</u>. The potential excess cancer risk to a resident drinking contaminated ground water as a primary water source over a lifetime ranges from one additional cancer case in 125 people (8×10^{-3}) to one additional cancer case in 50,000 people (2×10^{-5}). The potential excess cancer risk to a resident exposed only during their childhood ranges from one additional cancer case in 250 (4×10^{-3}) people to one additional cancer case in 100,000 people (1×10^{-5}). EPA generally considers risks greater than one excess cancer risk in 10,000 people unacceptable. The State of Washington has determined that risks above one excess cancer case in 100,000 people generally require action to address the risks.

<u>Non-Cancer Risks</u>. Non-cancer risks are measured by a system that generates a numeric value. Any value greater than 1.0 may indicate a need for action. The non-cancer risk for a lifetime of exposure to contaminated ground water ranges from 260 to 0.1. For a person exposed only during childhood the risk ranges from 780 to 0.24. These risks were determined based on concentrations at individual monitoring and extraction wells, and the highest values likely overestimate the actual risks, because ground-water concentrations will reduce over time and will not remain at the highest concentrations used to calculate risk.

Risks to future workers from exposures to lead and chromium at the Boomsnub Soil OU are less than exposures to ground-water contamination but are still elevated. Risks generally fall within 1 to 6 excess cancer risks in 100,000 people, depending on the exposure scenario evaluated. Several tables identified below provide details of EPA's baseline risk assessment for the Boomsnub Soil and Site-Wide Ground Water OUs.

6.1.5.1 Boomsnub Soil OU Conclusions

The potential excess cancer risks to future child/adult (i.e., lifetime) residents range from 1×10^{-4} (Lewis & Clark Railroad property) to 2×10^{-9} (Heuvel property) at the Boomsnub Soil OU (Table 6-1). The cancer risks for child receptors and industrial workers are less than the maximum noted for the future child/adult. The HIs range from 1.7 (Lewis & Clark Railroad property) to 0.2 (Heuvel property) for the future child (Table 6-2). The hazards for child/adult and industrial workers are less than the maximum noted for the future child.

The majority of risks and hazards associated with the shallow soils at the Boomsnub Soil OU for the hypothetical future resident scenario are attributable to concentrations of chromium, arsenic, lead, and benzo(a)pyrene. The potential future risks and hazards associated with these chemicals, with the exception of lead and an HI of 1.7 for a future child at the Lewis & Clark Railroad property (based on a potential exposure to arsenic), are within the range generally considered acceptable by EPA. The cancer risks are slightly above the MTCA threshold of 1×10^{-5}.

The Boomsnub Soil OU is zoned for light industrial use, where the maximum risk would be to future workers potentially exposed to contaminants present in the soil at the Site. The maximum estimated risks associated with contaminants identified at the Boomsnub Soil OU for a future worker is one excess cancer risk in 50,000 people (2×10^{-5}) from ingestion, inhalation and dermal contact over a lifetime exposure to all contaminants in soil except lead. Lead was detected at the Site in two localized areas exceeding the State of Washington cleanup standard for industrial soils of 1,000 ppm. Assumptions used to evaluate risk are based on conservative estimates, and actual risks would likely be lower.

While site risks at the Boomsnub Soil OU slightly exceed the State of Washington's cleanup standards for direct contact exposures, the primary risks associated with the Boomsnub Soil OU are from hexavalent chromium in soils migrating into ground water. As a result, soil cleanup alternatives were evaluated based on eliminating or significantly reducing this ongoing source of contamination to ground water. The alternatives evaluated for soil will also reduce potential exposure concerns to future workers at the Site.

6.1.5.2 Site-Wide Ground Water OU Conclusions

For a future resident using contaminated water from the Alluvial aquifer as a primary water source, significant risk would be anticipated from ingestion of inorganic and organic chemicals in the ground water. The potential excess cancer risk to future child/adult (i.e., lifetime) residents range from 8×10^{-3} to 2×10^{-5} and for children from 4×10^{-3} to 1×10^{-5} (Table 6-3). The majority of excess cancer risk calculated for ground-water ingestion is attributable to concentrations of TCE and 1,1-DCE. Arsenic (below background concentrations) and PCE also contributed to the cancer risk in lesser amounts.

The non-cancer HIs range from 260 to 0.1 for the child/adult receptor (Table 6-4) and from 780 to 0.24 for the child receptor (Table 6-3). Nearly all of the non-cancer hazards were attributable to either chromium or TCE. Industrial workers would have less risk or hazards than the adult resident receptors because Site ground water would not be their sole source of drinking water.

Of the wells evaluated, those with unacceptable risk levels include: MW-14E, MW-18D, MW-20D, PW-1B, AMW-2A, AMW-12A, MW-25D, and MW-26D. Although the risks were not calculated, other wells in the central portion of the plume are anticipated to have similar risk levels. However, because there is readily available municipal water in the area, there are no current unacceptable risks from consumption of ground water from the Alluvial aquifer.

The potential excess cancer risk associated with chemicals found in the Upper Troutdale aquifer are 6×10^{-5} and 2×10^{-5} for future child/adult and child receptors, respectively. Well AMW-24 (sampled to represent the Upper Troutdale aquifer) contained TCE and 1,1-DCE as the primary risk drivers. The HIs are 0.43 and 1.2 for future child/adult and child receptors, respectively, from all contaminants found in AMW-24. Given the level of uncertainty in this risk assessment, these potential risks and hazards are within the range generally considered acceptable by EPA, but the risks are slightly above the MTCA threshold of 1×10^{-5}.

The potential cancer risks associated with chemicals found in private wells range from 5×10^{-6} to 2×10^{-5} for future child/adult receptors and 2×10^{-6} to 9×10^{-6} for future child receptors. The potential non-cancer HIs range from 0.03 to 0.14 for future child/adult receptors and 0.07 to 0.41 for future child receptors. The cancer risks are only slightly above the MTCA threshold of 1×10^{-5}, but risks are mainly associated with arsenic. Because arsenic was detected below background levels, the concentrations detected in private wells do not present a health concern. If arsenic was not included in the risk evaluation, the cancer risk for private wells would fall below the MTCA threshold of 1×10^{-5}.

Tables within Appendix B provides risk estimates for the significant routes of exposure and HQs for each route of exposure and the HI (sum of hazard quotients) for all routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's exposure to soil and ground water, as well as the toxicity of the COCs. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a HI greater than 1 indicates the potential for adverse non-cancer effects.

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action identified as the selected remedy in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

6.1.6 Uncertainties

Uncertainties associated with this risk assessment include sampling and analytical methods, sample location and number of samples, the assumption that chemical concentrations remain constant over time, the use of conservative assumptions with regard to exposure parameters and toxicity values, and assumptions of additive risk for similar toxicological effects.

To evaluate the pathways associated with ground water under future Site conditions, the concentrations present in ground water were used to represent exposure point concentrations (EPCs) throughout the duration of exposure. No changes in concentrations as a result of natural dilution/attenuation or treatment processes were considered. Impacted ground water in its present state is unlikely to be used as a potable water source unless ground-water conditions improve. Consequently, the estimated carcinogenic risks and non-carcinogenic health effects from ingestion of chemicals in ground water may be overestimated.

Given the uncertainties associated with the human health risk assessment, it is expected that the risks presented are conservative and actual risks may be lower than those estimated in this assessment.

6.2 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more chemical releases at the Site. The objective of the ecological risk assessment was to estimate potential impacts to ecological receptors at the Site. The estimate of potential impacts was based on RI sampling and analyses conducted at the Site that determined the nature and extent of contamination that could potentially act as a stressor to ecological receptors.

The approach used to assess potential ecological impacts is conceptually similar to that used for human health risks and includes the following:

- Evaluation of data and identification of chemicals of concern (COCs),
- Identification of potentially exposed populations (receptors) and exposure pathways, and
- Combination of exposure and toxicity information to derive estimates of risk.

The Site-Wide Ground Water OU consists of impacted ground water. Contaminants present within the aquifer are not known to be released to any surface water bodies or to contact any potential receptors. The contaminants detected in the aquifer are not stressors to ecological receptors because no known complete exposure pathways exist. Therefore, only potential stressors at the Boomsnub Soil OU were evaluated in this ecological risk assessment.

The screening of contaminants detected at the Boomsnub Soil OU compared the maximum concentration of each contaminant detected at the OU to background concentrations and to conservative toxicity screening values derived from toxicity studies and exposure scenarios. The evaluation of soil at this OU included all contamination detected in surface soil samples (0 to 2 feet bgs) to which ecological receptors may be primarily exposed. The COCs selected for the Boomsnub Soil OU are hexavalent chromium and lead.

The species associated with the habitats at the Site have the potential to be exposed to COCs if exposure pathways are complete, and may, therefore, be considered potential receptors. The representative species are selected based on the species' likelihood of exposure considering their preferred habitat, their feeding habits, and their abundance at the Site. The representative species selected for the Boomsnub Soil OU include juniper, American robin, eastern cottontail, vagrant shrew, and earthworm.

Plants, such as the juniper, can be exposed primarily through uptake of dissolved contaminants and also through contaminants in the air. Wildlife, such as birds and mammals, may be exposed to COCs through a variety of pathways, including ingestion of plant and animal diet items; incidental ingestion of surface soil and sediments while foraging; ingestion of surface water used for drinking; dermal contact with contaminated soil, sediment, or surface water; and inhalation.

Earthworm exposure to COCs may result from ingestion of and/or dermal contact with contaminated soil. Exposure estimates for the representative species of mammals and birds (expressed as a unit of chemical ingested per unit of body weight) are based on their total exposure to COCs from diet, soils, and surface water. Exposure estimates for the representative species are based on the average concentration of the individual COCs in soil.

Potential risks to plants were evaluated based on the contaminant concentrations in the soil and information from current scientific literature. Potential risks to invertebrates, birds, and mammals were estimated by comparing estimated exposures to toxicity reference values (TRVs) (i.e., the quotient method) obtained from pertinent scientific literature reviews. The quotient method divides the estimated exposure concentration by the associated TRV to derive the hazard quotient (HQ). If the HQ is less than 1.0, then adverse effects are not expected. Conversely, if the HQ is equal to or greater than 1.0, a potential for adverse effects exists.

6.2.1 Ecological Risk Assessment Conclusions

It is unlikely that the average concentration of chromium at the Site will have any adverse effects on plant life. Plant uptake rates of chromium, to either vegetative or fruit portions, are low and the evaluation in the ecological risk assessment indicates that risks to plants at the Boomsnub Soil OU are likely to be very low.

As shown in Table 6-5, the HQs for the American robin, eastern cottontail, and vagrant shrew were significantly below 1.0 for potential exposure to hexavalent chromium and lead, indicating the potential risk to these species is not significant.

Potential risks to invertebrate species, represented by earthworms (i.e., Lumbricidae family), were evaluated by comparing toxicity information from the literature with the average exposure concentrations of potential contaminants in soil. An HQ value of 35.4 indicates that potential risk may exist for earthworms from exposure to hexavalent chromium. However, the use of average concentrations may skew the actual exposure estimates because many of the elevated concentrations are located in disturbed soil areas with low organic content (i.e., poor earthworm habitat), tending to overestimate the HQs. On that basis, there does appear to be a potential risk to earthworms; however, the actual risk may be less than the HQ value indicates.

The objective of the ecological risk assessment was to evaluate the potential risk to the representative plant, invertebrate, avian, and mammalian species at the Boomsnub Soil OU. This assessment indicates that risks posed by the COCs are currently not significant. As noted, there are no known potential exposure routes from the Site-Wide Ground Water OU to ecological receptors; therefore, no ecological risks are expected from contaminants in ground water.

Table 6-1
Summary of RME Cumulative Carcinogenic Risks
Boomsnub Soil OU

Exposure Unit	Future Child/Adult Resident	Future Child Resident	Industrial Worker
Boomsnub Property	6×10^{-5}	4×10^{-5}	1×10^{-5}
Voorhies	2×10^{-5}	1×10^{-5}	3×10^{-6}
Railroad	1×10^{-4}	6×10^{-5}	2×10^{-5}
Heuvel	2×10^{-9}	6×10^{-10}	7×10^{-10}
LaValley	1×10^{-5}	9×10^{-6}	2×10^{-6}

Table 6-2
Summary of RME Cumulative Non-carcinogenic Hazard Indices
Boomsnub Soil OU

Exposure Unit	Future Child/Adult Resident	Future Child Resident	Industrial Worker
Boomsnub Property	0.3	0.95	0.087
Voorhies	0.2	0.5	0.058
Railway	0.6	1.7	0.12
Heuvel	0.009	0.022	0.0029
LaValley	0.07	0.23	0.014

Table 6-3
Summary of Carcinogenic Risks and RME Non-carcinogenic HIs
Future Child Resident
Site-Wide Ground Water OU

Aquifer	Area Of Concern	Well	Risk	RME HI
Alluvial	"Hot-Spots"	MW-14E (97)	2×10^{-3}	700
Alluvial	"Hot-Spots"	MW-18D (97)	6×10^{-4}	330
Alluvial	"Hot-Spots"	MW-20D (97)	5×10^{-4}	280
Alluvial	"Hot-Spots"	PW-1B (97)	2×10^{-4}	60
Alluvial	"Hot-Spots"	AMW-2A (97)	1×10^{-3}	180
Alluvial	"Hot-Spots"	AMW-12A (97)	4×10^{-3}	780
Alluvial	Distal Extraction Wells	MW-25D (97)	1×10^{-4}	28
Alluvial	Distal Extraction Wells	MW-26D (97)	3×10^{-5}	29
Alluvial	Western Part of Plume	MW-28 (97)	1×10^{-5}	0.27
Alluvial	Western Part of Plume	MW-29 (97)	1×10^{-5}	0.26
Alluvial	Western Part of Plume	MW-30 (97)	9×10^{-6}	0.24
Alluvial	North and South Perimeter	AMW-22 (97)	1×10^{-5}	0.41
Alluvial	North and South Perimeter	AMW-23 (97)	1×10^{-5}	0.78
Alluvial	North and South Perimeter	CPU-12 (97)	2×10^{-5}	1.3
Alluvial	North and South Perimeter	CPU-15 (97)	9×10^{-6}	0.34
Upper Troutdale	Upper Troutdale Aquifer	AMW-24 (97)	2×10^{-5}	1.2

RME HI = reasonable maximum exposure hazard index

(97) = 1997 biannual ground-water data

Table 6-4
Summary of Carcinogenic Risks and RME Non-carcinogenic HIs
Future Child/Adult Resident
Site-Wide Ground Water OU

Aquifer	Area Of Concern	Well (year)	Risk	RME HI
Alluvial	"Hot-Spots"	MW-14E (97)	4×10^{-3}	260
Alluvial	"Hot-Spots"	MW-18D (97)	1×10^{-3}	120
Alluvial	"Hot-Spots"	MW-20D (97)	1×10^{-3}	110
Alluvial	"Hot-Spots"	PW-1B (97)	5×10^{-4}	23
Alluvial	"Hot-Spots"	AMW-2A (97)	3×10^{-3}	58
Alluvial	"Hot-Spots"	AMW-12A (97)	8×10^{-3}	250
Alluvial	Distal Extraction Wells	MW-25D (97)	3×10^{-4}	12
Alluvial	Distal Extraction Wells	MW-26D (97)	7×10^{-5}	12
Alluvial	Western Part of Plume	MW-28 (97)	3×10^{-5}	0.12
Alluvial	Western Part of Plume	MW-29 (97)	3×10^{-5}	0.11
Alluvial	Western Part of Plume	MW-30 (97)	2×10^{-5}	0.1
Alluvial	North and South Perimeter	AMW-22 (97)	3×10^{-5}	0.17
Alluvial	North and South Perimeter	AMW-23 (97)	3×10^{-5}	0.33
Alluvial	North and South Perimeter	CPU-12 (97)	4×10^{-5}	0.49
Alluvial	North and South Perimeter	CPU-15 (97)	3×10^{-5}	0.15
Upper Troutdale	Upper Troutdale Aquifer	AMW-24 (97)	6×10^{-5}	0.43

RME HI = reasonable maximum exposure hazard index

(97) = 1997 biannual ground-water data

Table 6-5
Hazard Quotients for Representative Species

Representative Species	COC	Estimated Exposure	TRV	Hazard Quotient
earthworms	hexavalent chromium	14.16 mg/kg in soil	0.4 mg/kg in soil	35.4[a]
	lead	439.64 mg/kg in soil	1,000 mg/kg in soil	0.44
American robin	hexavalent chromium	0.00016 mg/kg/day	0.95 mg/kg/day	0.0002
	lead	0.0097 mg/kg/day	1.15 mg/kg/day	0.008
eastern cottontail	hexavalent chromium	0.0003 mg/kg/day	0.98 mg/kg/day	0.0003
	lead	0.063 mg/kg/day	2.38 mg/kg/day	0.03
vagrant shrew	hexavalent chromium	0.062 mg/kg/day	5.47 mg/kg/day	0.11
	lead	2.002 mg/kg/day	13.33 mg/kg/day	0.15

[a]This HQ is not representative for the on-site earthworm population because the highest concentrations of Cr+6 are in areas not conducive to earthworm populations (i.e., rock fill on surface with little or no vegetation or humus in soil).

TRV = toxicity reference value

7.0 REMEDIAL ACTION OBJECTIVES

Based on the site risks, Remedial Action Objectives were developed to prevent people from being exposed to contaminated soil and/or ground water from the Site.

7.1 RAOs FOR BOOMSNUB SOIL OU

While Site risks at the Boomsnub Soil OU slightly exceed the State of Washington's cleanup standards for direct contact exposures, the primary risks associated with the Boomsnub Soil OU are from hexavalent chromium in soils migrating into ground water. As a result, soil cleanup alternatives were evaluated based on eliminating or significantly reducing this ongoing source of hexavalent chromium to ground water. As explained in section 5.5.1, the properties comprising the Boomsnub Soil OU are zoned for industrial use, and have a historical pattern of industrial activity that is expected to continue in the future. Therefore, the alternatives evaluated for soil have been developed to allow for continued industrial uses and will reduce potential exposure concerns to future workers at the Site. EPA has established the following RAOs for the Boomsnub Soil OU:

- Prevent hexavalent chromium in soils from serving as an uncontrolled, ongoing source of contamination to the down gradient ground-water plume
- Prevent future workers from being exposed to lead and chromium in soils above industrial cleanup standards

The soil cleanup standards for this Site are listed in Table 7-1. These cleanup standards are based on Washington State's MTCA soil cleanup standards which are the primary ARARs for the Boomsnub Soil OU. The MTCA Method A industrial soil cleanup standard for direct contact with lead is 1,000 ppm. The MTCA soil cleanup level for hexavalent chromium that is protective of ground water is 8 ppm. A Site-specific remediation level of 400 ppm has been selected to remove the highest concentrations of total chromium remaining in soils. As shown in Table 7-1, the remediation level for total chromium is more protective than the Method C industrial soil cleanup standards for both trivalent and hexavalent chromium, and will therefore ensure protectiveness for future workers.

In addition to being protective of future worker exposure, EPA selected a 400 ppm remediation level for total chromium to also be protective of ground water at the Site. This remediation level is based on a number of factors. EPA conducted both leach tests and hexavalent chromium analysis (described in section 5.2.2) in attempt to establish a correlation between total chromium values in soil and a corresponding hexavalent chromium value that could be expected to result. While this information provided some indication of the remaining hexavalent chromium in soils, a strong correlation with the measured total chromium values was not evident. In the absence of a strong correlation, EPA has used its best professional judgement to select an appropriate remediation level for the Site. In selecting a remediation level, EPA considered the future land use and the applicable MTCA regulations (173-340-745(4)(a)(ii)(A)). Based on the historical land use and current zoning, EPA expects the future land use to remain industrial. The applicable MTCA Method C standard for protection of future workers is 17,500 ppm for hexavalent chromium. However, to be protective of ground water at the Site, which is expected to be available for future residential use, the applicable MTCA Method C standard for hexavalent chromium is 8 ppm in soil. MTCA also allows a higher soil standard for protection of ground water if it can be demonstrated to be protective of ground water at the Site. At the Boomsnub Soil OU, protectiveness of ground water at the Site will be demonstrated by achieving MCLs or the applicable MTCA ground water cleanup standards. EPA will use existing monitoring wells near the Boomsnub property to evaluate the effectiveness of the selected soil remedy in achieving the RAO of preventing uncontrolled migration of hexavalent chromium to the Site-Wide Ground Water plume and meeting the MTCA soil cleanup levels.

7.2 RAOS FOR SITE-WIDE GROUND WATER OU

EPA has established the following cleanup objectives for the Site-Wide Ground Water OU:

- Prevent further impacts to the Alluvial aquifer
- Restore impacted ground water to drinking water standards (MCLs or MTCA B standards)
- Prevent ingestion of contaminated ground water above federal and state drinking water standards
- Prevent impacts to the Upper Troutdale Aquifer and the public drinking water supply by reducing contamination in the Alluvial aquifer

On the basis of the baseline risk assessment, the primary COCs for ground water are chromium, TCE, and 1,1-DCE. Remediation goals have been established for the primary COCs, other COCs that have been detected in monitoring wells above MCLs or MTCA ground-water cleanup standards, and for break down (or "daughter") products and possible daughter products of these COCs. Table 7-2 contains the cleanup standards for the ground-water COCs exceeding cleanup standards during the 1997 biannual sampling event. Because degradation occurs over time, monitoring of ground water will include the full list of VOCs to monitor for the presence of all Site-related VOCs exceeding cleanup standards. Arsenic is not listed as a ground-water COC based on detections at or below Clark County background concentrations (<1-4 ppb reported in USGS 1998) as well as the state background value of 5 ppb.

The area of attainment for which the above-remediation goals apply for the COCs at this Site will be throughout the ground-water plume in the Alluvial aquifer, currently as far west as NE 30th Avenue. The area of attainment in the Upper Troutdale aquifer will be the existing monitoring wells, including AMW-24, MW-33, and other wells impacted at the Site.

Table 7-1
Cleanup Levels for Soil Chemicals of Concern

Media: Soil
Site Area: Boomsnub Soil OU
Available Use: Industrial
Controls to Ensure Restricted Use (if applicable): Zoning for adjacent properties; deed restrictions for Boomsnub property only

Chemical of Concern	Cleanup Level (ppm or mg/kg)	Basis for Cleanup Level	Risk At Cleanup Level
Total Chromium	**400**	**Site-specific remediation level**[1]	NC
Chromium VI	8	MTCA 100x Ground-water Std.[2]	NC
	17,500	MTCA C Industrial	
Chromium III	1,600	MTCA 100x Ground-water Std.[2]	NC
Lead	1,000	MTCA A Industrial[3]	NA

NA - Not applicable
NC - Not calculated

Notes:
[1] The Site-specific remediation level will be demonstrated to be effective achieving the MTCA ground-water cleanup standard (80 ppb) for hexavalent chromium at nearby monitoring wells. Hexavalent chromium remaining in soil between 400 ppm and 8 ppm will be allowed to infiltrate to ground water for ex-situ ground water treatment.
[2] Soil cleanup level represents 100 times the MTCA ground-water cleanup level reported in the Ecology CLARCII database dated 2/28/96.
[3] MTCA Method A Industrial value shown for lead (no Method C Industrial value exists for lead).

Table 7-2
Cleanup Levels for Ground-Water Chemicals of Concern (1997 Data)

Media: Ground Water
Site Area: Site-Wide Ground Water OU
Available Use: Residential
Controls to Ensure Restricted Use (if applicable): Public Water Supplies Previously Provided to Impacted Property Owners

Chemical of Concern	CAS Number	MTCA B (µg/L or ppb)	MCL (ug/L or ppb)	Is MCL sufficiently protective?	Basis	Practical[1] Quantitation Limit (µg/L or ppb)	Cleanup[2] Level (µg/L or ppb)	Risk At Cleanup Level[3]
Hexavalent Chromium	18540-29-9	80	no MCL	NA	MTCA B	5	80	HQ = 1
Chromium (Total)	7440-47-3	no MTCA B	100	Yes	MCL	5	100	NC
Bromodichloromethane	75-27-4	0.706	100	No	MTCA B	1	1	NC
Carbon Tetrachloride	56-23-5	0.337	5	No	MTCA B	1	1	1.49×10^{-5}
1,2-Dibromo-3-Chloropropane	96-12-8	0.0313	0.2	Yes	MCL	1	0.2	6.40×10^{-6}
Dibromochloromethane	124-48-1	0.521	100	NC	MTCA B	1	1	NC
1,2-Dichloroethane	107-06-2	0.481	5	Yes	MCL	1	5	1.04×10^{-5}
1,1-Dichloroethene	75-35-4	0.0729	7	No	MTCA B	1	1	NC
Hexachlorobutadiene	87-68-3	0.561	no MCL	NA	MTCA B	5	5	NC
Tetrachloroethene	127-18-4	0.858	5	Yes	MCL	1	5	5.83×10^{-6}
1,1,1-Trichloroethane	71-55-6	7,200	200	Yes	MCL	1	200	HQ = 0.0278
Trichloroethene	79-01-6	3.98	5	Yes	MCL	1	5	1.26×10^{-6}

Notes:
[1]Ecology Implementation Memo #3 of November 24, 1993.
[2]Cleanup level established as the higher of the regulatory level or the PQL; see WAC 173-340-700(6) and Ecology Implementation Memo #3 of November 24, 1993.
[3] Where cleanup criteria is MTCA B, risk at cleanup level is calculated using MTCA assumptions.
CAS = Chemical Abstract Service
HQ = hazard quotient
MCL = maximum contaminant level
NA = not applicable
NC = not calculated

8.0 DESCRIPTION OF ALTERNATIVES

In light of past removal and enforcement activities conducted at the Site as of 1997, when the RI/FS was initiated, a limited number of alternatives were evaluated. Alternatives were assembled separately for the Boomsnub Soil OU and the Site-Wide Ground Water OU. Alternatives were assembled to represent varying levels of remedial action ranging from "no action" to treatment of chemicals of concern. Total costs presented below represent the present worth costs for 30 years assuming a 5% discount factor.

8.1 ALTERNATIVES FOR BOOMSNUB SOIL OU

8.1.1 Alternative Soil 1 (S1): No Action

The no action alternative provides a baseline for comparing other alternatives. It establishes the risk levels and site conditions if no remedial actions are implemented. Under the no action alternative Site conditions and risk levels would remain as they currently exist. No changes or restrictions would be made that would affect activities at the Site. No engineering or institutional controls would be put in place and no remedial actions would be initiated to reduce hazard levels at the site. Land development, site maintenance, and site improvements would continue without regard to Site conditions. There are no capital or operation and maintenance (O&M) costs associated with no action. By definition, no time would be needed to implement no action.

8.1.2 Alternative S2: Institutional Controls

Institutional controls refers to establishing legal restrictions and/or educational procedures to reduce the potential for exposure to contaminants. For example, the Boomsnub property is currently zoned for light industrial use so that residential uses would not be allowed. This eliminates the possibility of other commercial activities or residential uses with more significant exposure potential (e.g., daycare facilities). Institutional controls would also be used to establish maintenance and monitoring requirements for the Site. As with the no action alternative, this alternative would not treat or contain affected soil and existing potential exposure routes would remain. Alternative S2 assumes a minimal capital cost of $15,000 for implementing institutional controls. The O&M over 30 years accounts for $50,000 of the total present worth costs of $65,000 for Alternative S2. This alternative could be implemented in 1 to 3 months.

8.1.3 Alternative S3: Asphalt Capping

This alternative consists of installing a low-permeability asphalt cap over areas where chemical concentrations in soil exceed surface and subsurface cleanup goals. The intent of this action would be to minimize chemical transport by rainwater infiltration and to prevent dermal contact or ingestion of the affected soil by personnel working on Site. The asphalt cap would be maintained in perpetuity. Cap inspections and minor repairs would be made annually, or as needed. It is expected that the cap would sustain damage from weather and traffic use and repair would be required approximately every 10 years. Institutional controls would be needed to ensure the cap was not disturbed by future property development. The estimated capital cost of Alternative S3 is $108,000. The O&M costs for Alternative S3 over 30 years is $97,000 (or $6,340/year) for a total present worth of $205,000. The time needed to implement the asphalt capping of soils would range from 1 to 4 months, depending on the ability to obtain approval of the remedial design and contracting.

8.1.4 Alternative S4: Soil Flushing

Soil flushing would be used in and around the area of the former septic system located immediately west of the circular excavation from 1994. Deep contamination in the former septic area would be flushed from soil to ground water where the ground water would be collected for treatment. The soil flushing system would consist of a network of distribution pipes installed in shallow trenches above the former septic field area. Treated ground water would be injected onto the network to flush chromium into ground water. One or more new extraction wells would be installed just to the west of the flushing system to collect the ground water for treatment. In areas beyond the former septic area where contamination is less severe, chromium contamination in surface soil would be capped or excavated and transported to a disposal facility. The estimated capital cost of Alternative S4 is $308,000. The O & M cost for Alternative S4 over 30 years is $85,000 ($5,540/year) for a total present worth of $393,000. The time needed to implement the soil flushing remedy would range from 1 to 6 months, depending on the ability to obtain approval of the remedial design, contracting, and weather conditions.

8.1.5 Alternative S5: Soil Excavation and Off-Site Disposal

Under this alternative, the highest concentrations of chromium remaining in soil would be excavated and transported to an approved landfill off-site for treatment and disposal, as necessary. Remaining hexavalent chromium in soils would be allowed to migrate to ground water for capture by the ground-water extraction system. An estimated 878 cubic yards of soil would be excavated in this alternative using a remediation level of 400 ppm for total chromium. This remediation level would reduce direct contact exposures to safe levels for industrial uses and would remove soils with the highest chromium levels as a source of ground-water contamination. EPA has selected a 400 ppm remediation level for excavation because it is not practical to excavate all soils exceeding the MTCA Method B standard for soils to be protective of ground water of 8 ppm since much of that contamination exists below 15 feet. Institutional controls requiring deed restrictions would be used to prevent deeper subsurface soil contamination from being disturbed. Excavated areas would be backfilled with imported fill, and graded. Excavated material would be disposed of in a RCRA Subtitle C-approved landfill, if necessary. The estimated capital cost of Alternative S5 is $364,000, assuming disposal of all excavated material at a Subtitle C landfill. There are no annual O & M costs associated with this alternative. The time needed to implement the soil excavation and disposal remedy would range from 1 to 6 months, depending on the ability to obtain approval of the remedial design, contracting, and weather conditions.

8.2 ALTERNATIVES FOR SITE-WIDE GROUND WATER OU

EPA evaluated three basic technologies for the Site-Wide Ground Water OU: 1) ex-situ treatment of ground water via ground-water extraction and treatment with ion exchange and air stripping; 2) in-situ treatment of ground water via modified in-well stripping; and 3) in-situ treatment with permeable reactive barrier wall technology. These technologies were assembled in five different alternatives to provide realistic alternatives that could be implemented based on the treatability study results and other information gathered during the FS. The no action and institutional control alternatives were evaluated to form a baseline for comparing the other alternatives and to represent minimal response effort at the Site. A brief description of each of the alternatives is provided.

One of the issues common to the ex-situ ground-water treatment is disposal of the treated ground water. For the purposes of evaluating the remedial alternatives below, EPA assumed that the treated ground water would be conveyed to the City of Vancouver's Publicly Owned Treatment Works (POTW) after treatment. In the FS, EPA also evaluated an option to divert a portion of the treated ground water to an infiltration gallery that was constructed on the Boomsnub property where the soil removal took place. The infiltration gallery cannot be safely used until source control measures are in place up gradient at the BOC Gases Soil OU. If the infiltration gallery is used prior to source control at the BOC property, then VOCs present at the BOC Gases property could be spread laterally (north/south) by the water that is discharged to the infiltration gallery. However, once source control actions are in place at the BOC Gases property, EPA may use the infiltration gallery to reduce water disposal costs associated with sending water to the POTW. Use of the infiltration gallery would require compliance with ARARs and Ecology approval.

8.2.1 Alternative Ground Water 1 (GW1): No Action

This alternative is used to evaluate future conditions at the Site under the assumption that the existing interim remedial actions (extraction and treatment of ground water) would be terminated. The no action alternative provides a useful baseline for comparing the effectiveness of other alternatives. No controls are provided to control the migration or otherwise inhibit the use of contaminated ground water. Ground-water contaminants at the Site would continue to spread to uncontaminated areas, and over time may migrate into the Upper Troutdale aquifer. There are no capital or O & M costs associated with no action. By definition, no time would be needed to implement no action.

8.2.2 Alternative GW2: Institutional Controls

This alternative would implement safety measures to prevent exposure to contaminated ground water at the Site. Institutional controls could include placement of restrictive covenants in property deeds to prohibit the installation or use of ground-water wells for water supply. Contaminated ground water would not be treated or contained and would continue to spread to uncontaminated areas. Alternative GW2 assumes a minimal capital cost of $76,000 for implementing institutional controls. The O & M over 30 years accounts for $21,000 of the total present worth costs of $98,000 for Alternative GW2. This alternative could be implemented in 1 to 3 months.

8.2.3 Alternative GW3: 100 gallons per minute (gpm) Pump and Treat System

The current ex-situ ground-water treatment system was installed in 1994. Ion exchange and air stripping is used to treat contaminated ground water. The pump and treat system has a capacity of 100 gpm. Treated ground water is discharged under a permit to the City of Vancouver's POTW. GW3 involves operating and maintaining the existing ground-water treatment system currently in use at the Site. The system would operate at the current flow rate of approximately 100 gpm. The system comprises the ground-water extraction well network and conveyance piping; ion exchange system for chromium removal; an air stripping tower and vapor-phase carbon for VOC removal; a pressurized sewer line for discharge of treated ground water to the sanitary sewer system; and equalization tanks, holding tanks, pumps, electrical controls, and a remote telemetry system for off-site operation. The number of extraction wells increased during the interim action from 17 to 21 wells. Ground-water flow and transport modeling indicates that the existing 100-gpm extraction system is insufficient to contain the plume. The estimated capital cost of Alternative GW3 is $720,000. The O & M costs associated with continued operation of the existing pump and treat system for 30 years is estimated to be $10.9 million ($708,000/year) for a total present worth of $11.6 million. Implementation of this alternative would be immediate because only replacement or modification of existing equipment and installation of monitoring and extraction wells are required.

8.2.4 Alternative GW4: 200 gpm Pump and Treat System

This alternative upgrades the existing ion-exchange and air stripper treatment system to treat more ground water. Upgrades include construction of a new treatment building, modification or replacement of the air stripping tower, and construction of a larger sewer line. The upgraded system would be designed with a minimum capacity of 200 gpm, and ground water would continue to be discharged to the City of Vancouver POTW. The increased capacity would be used to ensure contamination does not spread beyond existing boundaries and also to focus efforts on removing more contaminants in areas of highest concentrations. Additional extraction wells would be constructed as needed near the western edge of the plume and along the centerline of the plume. An estimated three to six additional wells may be required, but the final number and location would be determined during remedial design. The estimated capital cost of Alternative GW4 is $2.7 million. The O & M costs for operating the 200 gpm pump and treat system for 30 years is $14 million ($911,000/year) for a total present worth of $16.7 million. (Note: the total present worth cost was incorrectly stated as $14 million in the FS and proposed plan; as a result of an omission in the FS report the capital and O&M costs were not totaled during the report preparation.) The time needed to implement the expansion of the pump and treat system would range from 1 to 6 months, depending on the ability to obtain approval of the remedial design, contracting, and weather conditions.

8.2.5 Alternative GW5: One Permeable Reactive Barrier

This alternative consists of installing one permeable reactive barrier (PRB) in the path of the contaminated ground-water plume. To create a PRB, a wall containing a zone of reactive material such as granular iron is installed along the width of the plume at a vertical depth coinciding with the flow of contaminated ground water. The contaminated ground water is treated as it flows through the iron. Contaminated ground water west of the PRB could be pumped out of the ground and either treated at a plant (like in alternative GW3 and GW4) or reinjected back into the ground water so that it flows through the PRB for treatment. For the cost estimate and comparative analysis of alternatives in Section 9.0, it is assumed that contaminated ground water west of the PRB would be treated at the existing treatment plant (see Section 12.0, "Feasibility Study Cost Estimates" for the rationale behind the ex-situ treatment component of this alternative). The PRB would be installed near monitoring wells MW-21D, MW-22D, and MW-23D (see Figure 5-5) downstream from the areas containing the highest levels of ground-water contamination. The iron would be placed in a 20-foot-thick zone at 50 to 70 feet below the ground and would be about 400 feet long from just north of monitoring well MW-23 to just north of NE 78th Street.

Column tests indicated that, depending on the concentration, chromium may be the chemical that determines the required wall thickness. The wall thickness required to treat the mass of chromium in the center of the plume was estimated to be approximately 1.5 feet. Therefore, the wall thickness required in the center of the plume would be 1.5 feet to treat chromium, with an additional 0.6 feet required for TCE removal. Considering a safety factor of 50 percent, the wall thickness required in the center of the plume is approximately 3 feet. The thickness of the wall would be reduced extending north and south from the center because the thickness of reactive material required is reduced as chromium and VOC concentrations decrease with distance from the center of the plume.

Wall installation would be accomplished with heavy construction equipment, and may require disposal of soil removed to place the iron. Few cases exist where a PRB has been successfully installed to a depth in excess of 50 feet. The top of the aquitard at the proposed placement location is approximately 70 feet bgs. Possible wall installation techniques include caisson emplacement, jet grouting, deep soil mixing, mandrels, vibrating beams, and vertical hydraulic fracturing. Jet grouting, vibrating beams, and emplaced hydraulic fracturing would require that the metal be conveyed and emplaced as a slurry. Mandrel emplacement is the installation technique assumed in the cost estimate for this alternative. No spoils are generated using the mandrel technique, but compaction and smearing of surrounding soil could result from displacement of soil as the mandrel is inserted, resulting in reduced permeability around the intended reactive zone. Further site characterization and final determination of the installation method to be used will be performed during remedial design if this alternative is implemented as part of the overall Site remedy. The estimated capital cost of Alternative GW5 is $5 million. The O & M costs for operating the PRB wall for 30 years would be $14.2 million (which assumes monitoring and operation of the existing 100 gpm pump and treat system but no wall replacement) for a total present worth cost of $19.2 million. Assuming wall replacement, the O&M cost for 30 years would rise to $17.5 million ($1.14 million/year) for a total present worth cost of $22.5 million. Installation of a single PRB is expected to require approximately 2 to 4 months. Before installation, additional site characterization would also be required along the alignment of the proposed PRB wall, which would lengthen the implementation time period. Therefore, the total time needed to implement the single PRB wall under Alternative GW5 would range from and estimated 6 months to 1 year.

8.2.6 Alternative GW6: Two Permeable Reactive Barriers

GW6 consists of installation of two PRBs in the path of the plume of contaminated ground water. This alternative differs from Alternative GW5 only in how contaminated ground water down gradient of the first PRB is treated. This alternative would use a second PRB rather than the extraction system to treat ground water at the western half of the Site. The first PRB would be installed in the same location as described in GW5. The second PRB would be placed to the north of NE 78th Street between the western edge of the Church of God property and NE 30th Avenue, in a 20-foot zone between 80 and 100 feet below the ground and about 400 feet long. The estimated capital cost of Alternative GW6 is $7.1 million. The O & M costs for operating the two PRB walls for 30 years would be $4.4 million (which assumes monitoring but no wall replacements) for a total present worth cost of $11.5 million. If wall replacement costs are included every 10 years, then the O&M costs increase to $11.2 million ($727,000/year), and the total present worth costs increase to a cost of $18.4 million. The time needed to implement the PRB walls under Alternative GW6 would range from 6 months to 1 year. Additional site characterization and access agreements would be required along the alignment of the proposed PRB walls, which would lengthen the implementation period.

8.2.7 Alternative GW7: Modified In-Well Stripping

The in-well stripping technology uses extraction wells to treat both chromium and VOCs in-situ. As ground water is drawn into the well, VOCs are stripped from ground water and captured for disposal as a hazardous waste. After removal of the VOCs in the stripping well, ground water would be directed to an 8-foot-diameter culvert and a chemical reductant would be added to reduce hexavalent chromium to less toxic trivalent chromium. Ground water would be allowed to re-enter the aquifer, where the trivalent chromium would bind to aquifer soils. In the conceptual design, about 10 modified in-well stripping wells are estimated to be needed. Four wells would be installed in a north-south line perpendicular to the ground-water plume, creating a barrier similar to GW5. Six additional wells would be installed at selected locations for treatment where contaminant concentrations are highest. Because application of in-well stripping would be a relatively new treatment technology and has not been proven to treat hexavalent chromium, ex-situ pump and treatment would be a component of alternative GW7 to increase the certainty of maintaining plume control and treating the leading edge of the ground-water plume. The existing pump-and-treat system would be operated at its current capacity of 100 gpm to treat the western half of the plume. The estimated capital cost of Alternative GW7 is $2.5 million. The O&M costs for operating the in-well stripping system for 30 years is $16.7 million ($1.09 million/year) for a total present worth of $19.2 million. The alternative could be constructed over a period of approximately 4 to 6 months. In-well stripping would require additional pilot-scale testing during design, which would lengthen the implementation period.

9.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

CERCLA, as amended by SARA, requires that the specific statutory requirements listed below be addressed in the Record of Decision and supported by the administrative record. Under CERCLA, remedial actions must meet these requirements:

- Protect human health and the environment
- Attain applicable or relevant and appropriate requirements (ARARs) unless justifications are provided for invoking a waiver
- Be cost-effective
- Use permanent solutions and alternative technologies or resource recovery technologies to the maximum extent practicable
- Address the preference for treatment that reduces toxicity, mobility, or volume

In addition, CERCLA emphasizes long-term effectiveness and encourages the evaluation of innovative technologies. To address these requirements, EPA has developed nine evaluation criteria as the basis for the detailed feasibility study evaluation and, subsequently, for selecting an appropriate remedial action. EPA groups the nine criteria into the following three categories, based on each criterion's role during remedy selection (Figure 9-1). A description of each criterion is presented along with the evaluation of each alternative in the following sections.

9.1 EVALUATION OF ALTERNATIVES—BOOMSNUB SOIL OU

The following text lists the Boomsnub soil alternatives in order from high to low relative to how well the criteria are satisfied, and compares the alternatives with one another under each criterion.

As noted for the ground-water analysis, both the "no action" and "institutional controls" alternatives were evaluated in the Feasibility Study. While these alternatives may receive a high ranking if evaluated based on the balancing criteria, they do not satisfy the threshold criterial of overall protectiveness and meeting ARARs, because little is done to address contamination at the Site. While institutional controls may be effective for reducing future worker exposures to soils on the Boomsnub Soil OU, it would be inadequate for addressing the ongoing source of contamination to ground water, which is the primary risk at the Site. For these reasons, the "no action" and "institutional controls" alternatives are not presented or discussed beyond the threshold criteria presented below. The remaining alternatives are presented under each criterion in the order of their ranking.

9.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Both S4 (Soil Flushing) and S5 (Soil Excavation and Off-Site Disposal) provide similar levels of protection, using slightly different approaches. S4 addresses human exposure to soil and protection of ground water.

Accessible areas of the Site would be capped and impacted soil would be removed from adjacent properties. In addition, chromium in soil in the most contaminated areas would be flushed, which would be expected to effectively remove the chromium and to eliminate future releases of chromium from soil to ground water in 2 to 3 years.

In S5 the most contaminated soil above 15 feet would be removed from the Site, ensuring that exposure to contaminated soil will not occur through industrial property uses. Protection of ground-water resources from contaminated soil below 15 feet would rely on annual rainfall to eventually flush chromium to ground water. The predicted time period for precipitation to flush contaminants is less certain for soil flushing, but it would not be expected to significantly increase the overall cleanup time period for ground water.

S3 (Asphalt Capping) would be protective of human health and the environment by limiting contamination from entering ground water. S3 would leave soil conditions relatively unchanged, and would rely on the cap in perpetuity to limit exposure and contaminant migration.

In S1 (No Action) no actions are taken, which leaves the potential for exposure to impacted soil. For S2 (Institutional Controls), no protection of ground water is provided to prevent leaching of contaminants from the property due to infiltration.

For overall protection of human health, the soil alternatives may be ranked in descending order as follows (most protective to least protective): S4 or S5, S3, and S2 or S1. The ranking of alternatives is based on a qualitative evaluation of the expected permanence and effectiveness of isolating subsurface soils from human contact. Alternatives S4 and S5 would most permanently and effectively protect the environment through actively treating or removing contaminated soil, thereby reducing the risk. S1 and S2 do not provide overall protection of the environment because exposure pathways and risks would not change from existing conditions.

9.1.2 Compliance with ARARs

This criterion evaluates whether a remedial action meets state and federal environmental laws and regulations that pertain to the site. The primary ARAR for soils is the MTCA soil cleanup standards. Alternatives S3 (Asphalt Capping), S4 (Soil Flushing), and S5 (Soil Excavation and Off-Site Disposal) would all comply with this ARAR. In addition, action-specific ARARs related to the underground injection control (WAC 173-218) would also be triggered under alternative S4. Alternative S5 would meet ARARs by excavation and disposal for the worst contamination, and rely on institutional controls for lesser concentrations at depth. S3 meets ARARs using institutional and engineering controls and compliance monitoring. S1 (No Action) and S2 (Institutional Controls) do not comply with MTCA cleanup goals for soils because neither alternative provides treatment or engineering controls to prevent higher concentrations from continuing to impact ground water. For compliance with ARARs, S4, S5, S3 would comply with ARARs. S1 or S2 would not reduce or control exposure to chemicals of concern, and therefore would not comply with MTCA soil cleanup standards.

9.1.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met.

S4 (Soil Flushing) and S5 (Soil Excavation and Off-Site Disposal) are ranked similarly for long-term effectiveness and permanence. The components of alternative S4, in-situ soil flushing of deep contamination, excavation and disposal of contaminated surface soil on adjacent properties, are protective of human health. Soil flushing would be effective in protecting the ground-water resource by eliminating an ongoing secondary source to ground-water contamination. S5, excavation and off-site disposal of soils, permanently removes the risk of human exposure through contact with contaminated soil and eliminates the most severe contamination remaining from the surface to 15 feet. Time frames for achieving remedial action objectives in the Site-wide Ground Water plume are not expected to be significantly longer under S5 than S4. In either alternative, operation of extraction wells in the immediate vicinity of the Boomsnub Soil OU will be used to prevent contaminants from migrating down gradient from the Boomsnub property.

S3 (Asphalt Capping) ranks below Alternatives S5 and S4 in terms of long-term effectiveness and permanence. The asphalt-capping alternative is effective in reducing infiltration and protection of human health due to exposure, but the long-term effectiveness of this option depends on periodic maintenance of the cap and no contamination is permanently removed.

For long-term effectiveness for human health, the soil alternatives may be ranked in descending order as follows: S4 or S5 and S3. The ranking is based on a qualitative evaluation of the expected long-term effectiveness in isolating subsurface soils from human contact.

9.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion evaluates a remedial action's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of residual contamination remaining.

S4 (Soil Flushing) treats the most severe chromium contamination by flushing contaminants to ground water for treatment by the selected ground water alternative. S5 (Soil Excavation and Off-Site Disposal) would provide treatment of excavated soils at the designated off-site disposal facility, as necessary. S3 (Asphalt Capping) relies on engineering controls to limit mobility and reduce exposure, but does not provide treatment. For reduction of toxicity, mobility, or volume through treatment, alternatives S4 and S5 provide treatment via the ground water remedy, for chromium that leaches to ground water. S5 will also provide any treatment necessary for excavated soils to comply with RCRA Land Disposal Restrictions. S3 does not provide treatment for ground water.

9.1.5 Short-term Effectiveness

Short-term effectiveness considers how fast a remedial action reaches the cleanup goal and the risk that the remedial action poses to workers, residents, and the environment during the construction or implementation of the remedial action.

S5 (Soil Excavation and Off-Site Disposal) would immediately remove the most severe contamination remaining, and allow precipitation to flush the residual hexavalent chromium to ground water. S4 (Soil Flushing) would achieve cleanup goals in 2 to 3 years of soil flushing. S4 and S5 both involve excavation of soils, which would generate dust, but routine health and safety measures (e.g., protective clothing for workers, and dust suppression) would protect remedial workers and nearby businesses. Truck traffic from transport of contaminated soils would also increase for a limited time, but routes would be coordinated with businesses in the area to minimize impacts.

S3 (Asphalt Capping) would immediately reduce infiltration and exposure to soils, but would rely on engineering controls in perpetuity to control the contamination.

For short-term effectiveness, the soil alternatives may be ranked in descending order as follows: S4 or S5 and S3.

9.1.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

S3 (Asphalt Cap) would be the easiest alternative to implement. An asphalt cap could be put in place very quickly, with minimal intrusion or inconvenience to neighboring properties.

S4 (Soil Flushing) and S5 (Soil Excavation and Off-Site Disposal) are considered routine remedial construction projects and are easily implemented. Increased traffic from excavation activities would be coordinated with adjacent business owners and tenants to minimize intrusion.

In general, the more activity involved in construction and operation of an alternative, the more likely it is that difficulties would be encountered during implementation. Accordingly, S3 would be the most readily implemented, followed by either S4 or S5.

9.1.7 Cost

Capital, operation and maintenance, and present worth costs of the soil alternatives are summarized in Table 9-1. Based on EPA guidance, the cost estimates were developed to be accurate to a range of -30 percent to +50 percent, given the available information. Thus an estimated cost of $10,000,000 represents a range of probable costs between $7,000,000 and $15,000,000.

The soil alternatives may be ranked on the order-of-magnitude estimated total present worth cost in ascending order (least to most costly) as follows: S3, S5, and S4.

9.1.8 State Acceptance

The State of Washington concurs with the selection of S5 to excavate and dispose of total chromium in soils above a Site-specific remediation level of 400 ppm for the Boomsnub Soil OU.

9.1.9 Community Acceptance

Comments received during the public comment period indicate that the public accepts the selected remedial action to excavate the highest remaining chromium concentrations in soils at the Boomsnub Soil OU. A responsiveness summary of the comments is provided as an appendix to this document.

The issues that were discussed during the public meeting and in subsequent written comments included the following:

- More explanation for EPA's 400 ppm remediation level for excavation of chromium in soils
- Recommendation that additional geoprobe (ground-water) samples be taken to determine the source of chromium in soils at the Boomsnub Soil OU
- Request for a cost/benefit analysis to establish the benefit of soil excavation over soil flushing

None of the identified issues resulted in changes to the preferred alternative.

9.2 EVALUATION OF ALTERNATIVES—SITE-WIDE GROUND WATER OU

The Site-Wide Ground Water OU alternatives are presented here in order from high to low relative to how well the criteria are satisfied. A comparison of the alternatives with each other under each criterion summarizes EPA's analysis conducted in the Feasibility Study.

The "no action" and "institutional controls" alternatives do not provide overall protection of human health and the environment, nor do they meet ARARs for the Site. Because EPA cannot select an alternative that does not satisfy these criteria, these two alternatives are not carried forward for evaluation beyond the threshold criteria.

9.2.1 Overall Protection of Human Health and the Environment

This criterion addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

GW4 (200 gpm Pump and Treat System) utilizes a reliable and proven technology to hydraulically control the spread of contamination in the Alluvial aquifer and to treat contaminants at the Site. With the increased capacity of 200 gpm, this alternative also maximizes contaminant removal. Pump and treat systems are less efficient as contaminant concentrations reach cleanup levels, but the technology is reliable for controlling the migration of contaminants.

GW5 (One Permeable Reactive Barrier) and GW7 (Modified In-Well Stripping) both treat contaminants via proven chemical processes, and have been demonstrated to work at other sites. However, both contain some uncertainties for application at this Site. GW7 is has been proven for cleanup of VOCs, but not for treatment of chromium. In addition, the in-well stripping technology is less proven than pump and treat technologies at providing hydraulic containment.

GW5 is anticipated to be effective for removing hexavalent chromium from ground water, and breaking down VOCs to their non-toxic elemental components (ethenes and carbon dioxide). The long-term effectiveness of the PRB technology remains to be seen. All installations of the PRB technology have been within the last 5 years. In addition to factors stated in GW5, installing the second barrier under GW6 (Two PRBs) would be complicated by a deeper installation depth to 100 feet and short-term impacts on the Bonneville Power Administration (BPA) power lines and daycare facilities nearby.

Under GW3 (100 gpm Pump and Treat System), the maximum treatment capacity of the existing treatment system is insufficient to contain the contaminant plume. Contaminants would be allowed to migrate farther west over time, which would impact neighboring ground-water resources. Although this alternative was carried forward for evaluation in the balancing criteria, EPA has determined that this alternative does not provide for overall protection of human health and the environment as a final remedy for the Site.

Under GW1 (No Action) and GW2 (Institutional Controls), the plume will continue to migrate farther west, potentially threatening municipal water supplies. For GW1 no treatment would be performed and no engineering controls would be provided to manage plume migration. No institutional controls would prevent extraction and consumption of contaminated ground water for GW1. GW2 would rely only on zoning or other institutional controls for ground-water use to prevent exposures.

In terms of overall protection of human health, the ground-water alternatives may be ranked in descending order (highest to lowest): GW4, GW7 or GW5, GW6, GW3, and GW2 or GW1.

9.2.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations, which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes or provides a basis for a invoking waiver.

The primary ARAR for all ground-water alternatives is federal and state drinking water standards. GW4 (200 gpm Pump and Treat System), GW5 (One PRB), and GW6 (Two PRBs) all utilize technologies that meet ARARs. GW4 employs proven methods to reduce ground-water contamination and prevent further migration of contaminants beyond current boundaries. GW4 will also meet ARARS for discharging treated water to the City of Vancouver's POTW.

GW5 and GW6 utilize relatively new remediation technologies that have been proven to treat ground water contaminated with VOCs and hexavalent chromium (Cr VI) to within ARARs. GW5 would rely on the existing extraction well network to provide hydraulic control of the chromium and VOC plumes and prevent further contaminant migration and would meet ARARs for that part of the plume by ex-situ ground-water treatment.

GW7 (Modified In-Well Stripping) can meet ARARs for VOCs, but has not been demonstrated to meet ARARs for chromium. This alternative would have to rely on the pump and treat system at the west to meet ARARs for chromium.

The existing 100 gpm pump and treat system (GW3) would meet ARARs in the area influenced by the extraction wells, but may not meet ARARs beyond the area influenced by the current extraction system.

Neither GW2 (Institutional Controls) nor GW1 (No Action) will meet ARARs for ground-water quality.

For compliance with ARARs, ground-water alternatives GW4, GW5, GW6 and GW7 will comply with ARARs. GW3, GW2 and GW1 are not expected to comply with MCLs and MTCA ground-water cleanup standards.

9.2.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met.

GW4 (200 gpm Pump and Treat System) extracts contaminated ground water to permanently remove contaminants from the aquifer. There is high confidence that this technology will effectively control plume* migration over the long-term and continue contaminant mass removal in the near term. Pump and treat systems become less effective at removing contaminants as concentrations approach cleanup goals.

GW5 (One PRB), GW6 (Two PRBs), and GW7 (Modified In-Well Stripping) all rank below GW4 due to the lack of performance data for the technologies from similar sites. Because these technologies are relatively new they lack long-term performance data from other sites. The permanence of chromium immobilization within the reactive barrier for GW5 and GW6 is expected to be excellent. VOCs would react with iron in the wall, breaking down to nontoxic chemical components. However, uncertainties remain about the effective life span of the barrier, the required thickness, and potential for plugging after the first 5 years that could divert ground-water flow to uncontaminated areas.

For GW7, a 4-month pilot study at the Site resulted in lower than expected treatment efficiencies for VOCs within the treatment zone, which would lengthen the time period required for treatment. Chromium removal was not effective in the pilot study. These results lead to uncertainties for the long-term effectiveness of GW7 at full-scale application. Further pilot-scale studies during remedial design and a phased implementation approach would be necessary to understand the long-term performance that could be achieved at this Site.

GW3 (100 gpm Pump and Treat System) is not considered to be effective in the long-term because modeling indicates containment of contaminants cannot be achieved at an extraction rate of 100 gpm.

For long-term effectiveness in protecting human health, the ground-water alternative may be ranked in descending order as follows: GW4, GW5 or GW6, GW7, and GW3.

9.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion evaluates a remedial action's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of residual contamination remaining.

GW4 (200 gpm Pump and Treat System) extracts contaminants for treatment by ion-exchange and air stripping, the same as the existing treatment system. The existing interim action pump and treat system has shown that contaminants can be treated below the permit-required discharge limits with this technology.

GW5 (One PRB) and GW6 (Two PRBs) would reduce VOCs to their elemental constituents (ethene and carbon dioxide) in a chemical reaction as contaminants pass through the iron in the wall. Chromium would be treated and remain in the barrier wall as trivalent chromium.

GW7 (Modified In-Well Stripping) was evaluated during a 4-month pilot study at this Site. The results of the study indicated that treatment efficiencies for VOCs were less than the 95%+ efficiencies originally anticipated, but that treatment does occur. The treatability study did not prove that modified in-well stripping would treat chromium.

Ground-water modeling shows that GW3 (100 gpm Pump and Treat System) is inadequate to contain the ground-water plume and consequently the plume is only partially treated. Optimization of the system to improve the efficiency of contaminant removal cannot be implemented because the majority of the system's capacity is devoted to keeping the plume from spreading farther west.

For reduction of toxicity, mobility, or volume through treatment, all ground-water alternatives, GW4, GW5, GW6, GW7 and GW3, rely on treatment to address the principal contaminants.

9.2.5 Short-term Effectiveness

Short-term effectiveness considers how fast a remedial action reaches the cleanup goal and the risk that the remedial action poses to workers, residents, and the environment during the construction or implementation of the remedial action.

Ground-water modeling results indicated that it would take at least 20 years to achieve cleanup objectives regardless of the technology used, so cleanup times did not provide a clear distinction between GW4 (200 gpm Pump and Treat System), GW7 (Modified In-Well Stripping), GW5 (One PRB), and GW6 (Two PRBs). These ground-water alternatives were also ranked based on the level of remedial construction required to implement each option. GW4 is ranked above GW7 because additional treatment units at each cluster(s) of stripping wells would be required, slightly increasing the needed safety measures to limit public access to these areas, while GW4 involves upgrades to the existing system. GW5 and GW6 are ranked lower because they require large-scale construction equipment to install the wall. It also may be necessary to replace the iron after a period of operation. If necessary, this would entail a second construction effort that would be similar to the initial installation.

GW3 (100 gpm Pump and Treat System) would mostly contain the contamination from spreading, but would not reach cleanup goals in some areas even after 30 years. Continued use of the current treatment system would not impact the environment or the community in the vicinity of the Site more than is currently occurring. Worker exposure is limited through proper training and use of protective clothing.

For short-term effectiveness, the ground-water alternatives may be ranked in descending order as follows: GW4, GW7, GW5 or GW6, and GW3.

9.2.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, coordination with other governmental entities, and whether the technology has been used successfully at similar sites are considered.

Under GW3 (100 gpm Pump and Treat System) the ground-water system has already been built and proven to be reliable within its capacity limits. Periodic repairs or equipment replacement to the existing treatment system would be expected. System improvements to limit the number of system faults and system down time would be needed, and a new sewer discharge pipeline is required.

Ion exchange and air stripping under GW4 (200 gpm Pump and Treat System) are proven technologies identified as presumptive remedies by EPA for treatment of ground water. These technologies are reliable in treating the chemicals of concern and no significant technical problems in implementing this alternative are anticipated.

In-well stripping under GW7 is a proven technology for VOC treatment, but not for chromium. Treatment efficiencies in Site-specific studies were not as good as predicted for VOCs and results were difficult to interpret for chromium. If additional pilot studies produce more favorable results, the implementability of this alternative would improve because the system is easy to construct, requiring well installations similar to the pump and treat alternatives GW4 and GW3. Because there is no water handling outside the well, GW7 may be more easily implemented as a stand alone system than GW4, assuming the pilot study is successful.

Both alternatives, GW5 (One PRB) and GW6 (Two PRBs), use the same technology and would be implemented using the same construction techniques. There have been few successful PRB installations below 50 feet in depth. PRB technology is relatively new and has been used at sites only within the past 5 years; its ability to treat over the long term (20 years) has not yet been demonstrated. Site-specific bench-scale treatability studies indicated that the wall might experience some plugging, which may result in the wall needing replacement after 5 to 10 years. GW5 is ranked above GW6 under this criterion because installing an additional PRB at the leading edge of the plume may require installation around BPA power lines, further complicating installation.

In general, the more activity involved in construction and operation of an alternative, the more likely it is that difficulties would be encountered during implementation. Accordingly, GW3 would be the most readily implemented, followed by GW4, GW7, GW5, and GW6.

9.2.7 Cost

Capital, operation and maintenance, and present worth costs of the ground-water alternatives are summarized in Table 9-2. Based on EPA guidance, the cost estimates were developed to be accurate to a range of -30 percent to +50 percent, given the available information. Thus an estimated cost of $10,000,000 represents a range of probable costs between $7,000,000 and $15,000,000. Present value calculations assume a discount rate of 5%.

9.2.8 State Acceptance

The Washington State Department of Ecology (Ecology) concurs with the selected remedy, ex-situ ground-water treatment at 200 gpm, as described above, for the Site-wide Ground Water OU. Ecology has requested that the selected remedy be reviewed at specified periodic intervals to reevaluate the efficiency of the ex-situ ground-water treatment system versus available in-situ treatment technologies (e.g., GW5). This review is described in detail in Section 10.2.1.

9.2.9 Community Acceptance

EPA received written and/or oral comments from four parties during the public comment period. All the comments expressed general support for GW4, EPA's continued operation of the ground-water treatment system, but at an increased rate of 200 gpm. The issues that were discussed during the public meeting and in subsequent written comments are briefly described here.

One commentor made several comments requesting clarification of specific details presented in EPA's proposed plan and making specific recommendations. The more significant of those comments and recommendations are paraphrased below:

- Request for clarification of the cleanup standard for 1,1-DCE and TCE

- Request for clarification of how extensively EPA would implement the in-well stripping technology. Specifically, the commentor recommended that the selected remedy allow the possibility that in-well stripping could be implemented at full scale, replacing the pump and treat system, if proven effective for treatment of chromium and VOCs

- Request that an alternative with in-well stripping alone (without pump and treatment) be included

- Request that replacement costs for a permeable reactive barrier be factored into GW5 and GW6

Another commentor was supportive of EPA's preferred alternative and expressed concerns over safety issues associated with alternative GW6 in installing a permeable reactive barrier wall east of NE 30th Avenue near BPA's electrical transmission lines.

Two commentors expressed support of EPA's preferred alternative.

EPA has addressed these comments in preparing this Record of Decision by adding additional information where appropriate to the text, and by summarizing these clarifications in Section 12.0 Documentation of Significant Changes. A response to each comment is provided in the Responsiveness Summary (Appendix A). None of the identified issues resulted in significant changes to EPA's preferred alternative.

Table 9-1
Cost of Boomsnub Soil Alternatives
(All amounts adjusted to present value in thousands of dollars)

Alternative	Capital Cost	Annual Operation and Maintenance Cost	30-Year Estimated Period of Operation[1]	
			Operation and Maintenance Cost	Total
S3 (Asphalt Cap)	$108	$6.34	$97	$205
S5 (Soil Excavation And Off-Site Disposal)	$364	$0	$ 0	$364
S4 (Soil Flushing)	$308	$5.54	$85	$393

Table 9-2
Cost of Site-Wide Ground Water Alternatives
(All amounts adjusted to present value in millions of dollars)

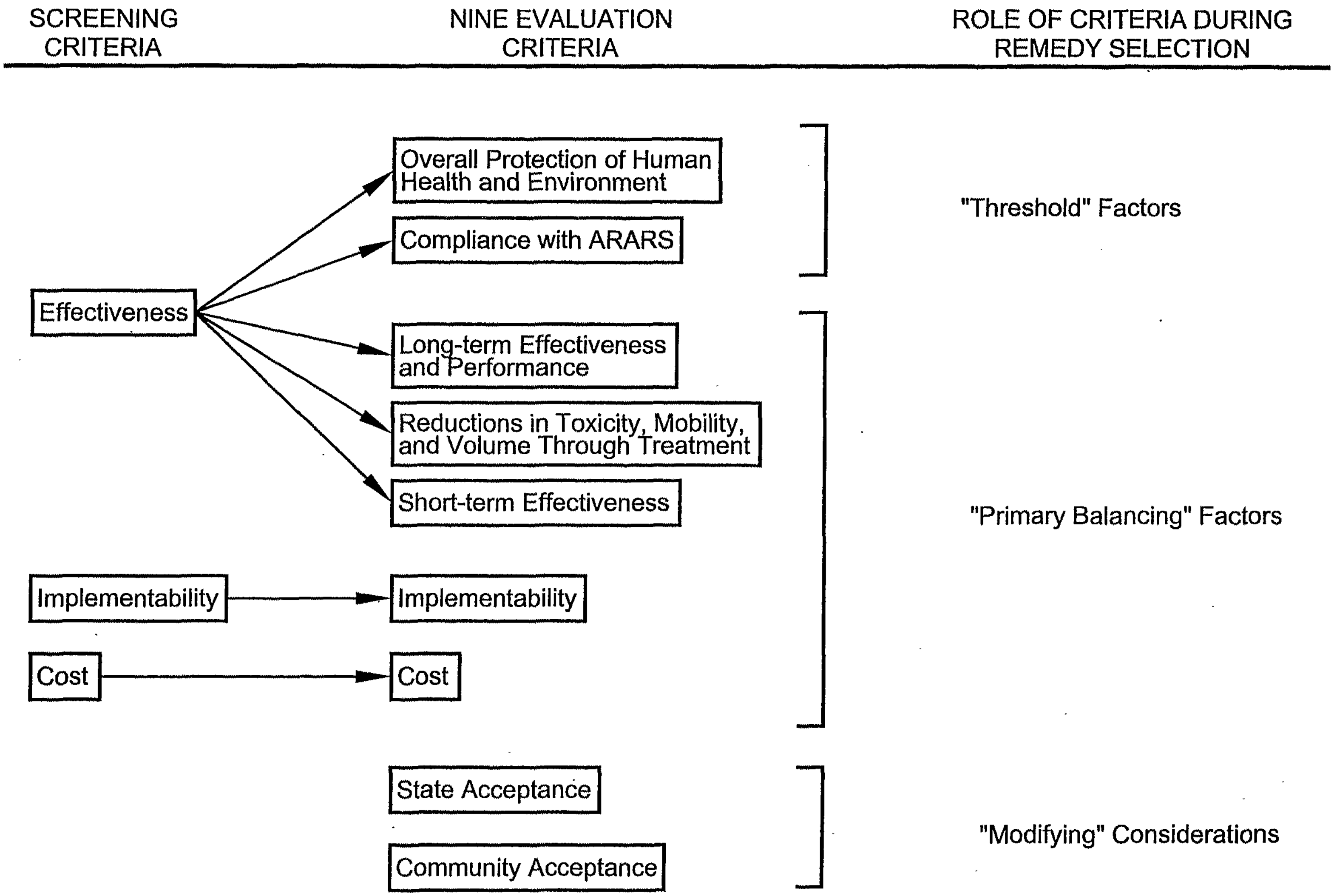
Alternative	Capital Cost	Annual Operation and Maintenance Cost	30-Year Estimated Period of Operation[1]	
			Operation and Maintenance Cost	Total
GW3 (100 gpm P&T)	$0.7	$0.708	$10.9	$11.6
GW4 (200 gpm P&T)	$2.7	$0.911	$14.0	$16.7[2]
GW6 (2 PRBs)	$7.1	$0.727	$11.2	$18.4
GW7 (IWS & 100 gpm P&T)	$2.5	$1.09	$16.7	$19.2
GW5 (PRB w/100 gpm P&T)	$5.0	$1.14	$17.5	$22.5

[1]Because the time required for each alternative depends on factors that are uncertain, EPA believes that the 30-year cost scenario is the most appropriate estimate because it accounts for these uncertainties.

[2]The total present worth cost was incorrectly stated as $14 million in the FS and proposed plan. As a result of an omission in the FS report the capital and O&M costs were not totaled during the report preparation.

GW5 - Represents the cost of one PRB with 100 gpm pump and treat assuming wall replacement at 10-year intervals. An ex-situ treatment component is part of this alternative to address uncertainties in the implementability and long-term effectiveness criteria (see Section 12.0, "Feasibility Study Cost Estimates" for further explanation).

GW6 - Represents the cost of two PRBs assuming wall replacements at 10-year intervals.



EPA REGION 10

Figure 9-1
Relationship Between Screening Criteria and the Nine Evaluation Criteria

RECORD OF DECISION
Boomsnub/Airco Superfund Site
Hazel Dell, WA

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EDIT DATE: 09/28/99 AT: 15:02

10.0 SELECTED REMEDY

This action addresses two of three OUs at the Site, the Boomsnub Soil OU and the Site-Wide Ground Water OU. The BOC Gases Soil OU will be addressed under a separate action for source control of ground water within the BOC Gases property boundaries.

10.1 BOOMSNUB SOIL REMEDY

The selected remedy is alternative S5, soil excavation and off-site disposal of contaminated soil at an approved landfill. The chemicals of concern in soils are lead and hexavalent chromium. Lead exceeded MTCA industrial soil cleanup standards for direct contact exposure. Chromium exceeded soil cleanup standards specified in MTCA for the protection of ground water. The goals of this selected remedy are to: 1) prevent hexavalent chromium in soils from serving as an uncontrolled, ongoing source to ground water, and 2) prevent future site workers from being exposed to lead in soils above industrial cleanup standards. The selected remedy will accomplish these goals through completion of the following actions:

- excavate total chromium in soils above a 400 ppm remediation level to a maximum depth of 15 feet on the Boomsnub, LaValley, Voorhies, and Lewis and Clark Railroad properties to remove the highest concentrations of total chromium in soils and be protective of future workers;
- treat hexavalent chromium in soils at concentrations greater than the 8 ppm MTCA cleanup standard for protection of ground water, and less than the 400 ppm remediation level by allowing infiltration of hexavalent chromium to ground water for treatment by the selected ground-water remedy;
- excavate lead in soil above the MTCA Method A industrial cleanup standard of 1,000 ppm on the Voorhies and Boomsnub properties;
- conduct confirmation sampling to ensure total chromium and lead in soils greater than remediation levels and cleanup levels, respectively, have been excavated. The maximum practical excavation depth is 15 feet;
- import clean soil and backfill excavated areas to grade. Ensure adequate drainage of excavated areas, using gravel for surface grading as necessary;
- test excavated soil to determine the method of disposal and dispose of excavated soil at an off-site Subtitle C hazardous waste facility or Subtitle D solid waste facility, as necessary; if needed, treat excavated soil to meet RCRA Land Disposal Restriction treatment standards;
- place deed restrictions on the Boomsnub property to maintain industrial land use of the property and prevent soil below 15 feet from being disturbed. No deed restrictions will be required for the LaValley, railroad and Voorhies properties;
- long-term monitoring of PW-1B, MW-4B or other wells as appropriate to demonstrate that the 80 ppb MTCA ground-water cleanup standard for hexavalent chromium in ground-water has been achieved as a result of the soil removal.

EPA believes the 400 ppm remediation level will be protective of ground water at the Site because it will remove the highest total chromium concentrations remaining on the property. A lower remediation level has not been selected at this time because no correlation exists in the available data to justify selecting a lower remediation level. EPA will rely on empirical data from future ground-water monitoring to determine that hexavalent chromium in soils has been adequately remediated by the 400 ppm remediation level to be protective of ground water at the Site. If EPA determines it is necessary, additional actions or a revision of the RAOs for the Boomsnub Soil OU may be considered in the future.

10.1.1 Rationale for Selected Soil Remedy

S5 immediately removes the highest concentrations of chromium in soils. Soil flushing (S4) is expected to require two years to flush contaminants from the former septic tank area, where the most severe contamination remains. By contrast, soil excavation would immediately remove the worst contamination remaining in the former septic area and significantly reduce the chromium that would enter ground water. Any leachable chromium remaining in soils will migrate to ground water during normal precipitation events, similar to the soil flushing alternative, but is expected to be lower in concentration and total mass since S5 will excavate the highest concentrations of chromium remaining in soils. For these reasons, EPA believes alternative S5 and the Site-specific remediation level offers the best balance of cost and effectiveness for addressing the ongoing source of contamination to ground water.

10.2 SITE-WIDE GROUND-WATER REMEDY

The selected ground-water remedy is GW4, expansion of the interim action ground-water extraction and ex-situ treatment system to treat hexavalent chromium and VOCs with ion exchange and air stripping, respectively. The goals of this selected remedy are to: 1) prevent further impacts to the Alluvial aquifer; 2) restore contaminated ground water in the Alluvial aquifer for use as a potential drinking water source; 3) prevent ingestion of contaminated ground-water from the Site above drinking water standards; and 4) prevent impacts to the Upper Troutdale aquifer caused by contamination migrating from the Alluvial aquifer.

The chemicals of concern for the OU are primarily hexavalent chromium and TCE in ground-water. These contaminants exceed federal drinking water standards and more stringent MTCA cleanup standards. Other metals and VOCs have been detected sporadically during monitoring at the Site: 1,1-DCE, and tetrachloroethene (PCE) are two of the more frequently detected contaminants exceeding a cleanup standard that also contribute to the overall risk at the Site. Numerous other COCs exceed cleanup standards, but do not represent a significant percent of the overall risk. All COCs from the Site exceeding a cleanup standard are subject to this remedial action and must meet the applicable standard.

The area of attainment for the COCs at this Site will be throughout the ground-water plume in the Alluvial aquifer. The area of attainment in the Upper Troutdale aquifer will be the existing monitoring wells, including AMW-24, MW-33, and other monitoring wells impacted at the Site at which MCLs or MTCA B ground-water cleanup standards must be achieved.

The selected remedy will accomplish these goals by taking the following actions:

- upgrade the existing ion-exchange and air stripper for ex-situ ground-water treatment by increasing the capacity of the ground-water treatment system, including increasing the capacity of the conveyance pipe and discharge pipeline from 100 gpm to a minimum 200 gpm capacity;
- improve the treatment building and other structural facilities to prevent wear and tear on the treatment system and allow for necessary expansion;

- continue pumping from the existing 21 extraction wells or some combination of these wells, adding new wells as needed to optimize the removal and treatment of contaminants;

- conduct long-term compliance monitoring biannually in the Alluvial and Upper Troutdale aquifers using existing monitoring wells, and new wells as necessary, to determine the effectiveness of the selected remedy in achieving the remedial action objectives. The frequency of compliance monitoring for the area of attainment and points of compliance may be modified by EPA as appropriate. Cleanup levels for all VOCs and metals detected in 1997 at the Site above cleanup standards are listed in Section 7.0, Table 7-2 including:

▸ TCE	5 ppb (MCL)
▸ total chromium	100 ppb (MCL)
▸ hexavalent chromium	80 ppb (MTCA)
▸ 1,1-DCE	1 ppb (MTCA/PQL)

- provide institutional controls in the form of public notice during operation of the ground-water pump and treat system, accomplished by providing affected property owners a copy of biannual ground-water quality sampling data for their property for all contaminants exceeding cleanup standards;

- discharge treated water to the City of Vancouver POTW in compliance with permit # 99-03. EPA may evaluate discharging treated ground water to the infiltration gallery on the Boomsnub property after source control actions up gradient at the BOC Gases property are in place. Wastes from ion exchange resin and will be disposed of at an appropriate RCRA Subtitle D or C landfill, and wastes from the granular activated carbon will be sent off-site for treatment/regeneration;

- evaluate the effectiveness of the ex-situ ground-water treatment system no less than every five years until monitoring demonstrates that remedial action objectives have been achieved. At each five-year review EPA will also reevaluate available literature on the permeable reactive barrier technology to see if it has proven to be a reliable long-term technology at other similar sites;

- develop as part of remedial design an extended In-Well Stripping treatability test for a 12 to 18 month duration for potential use throughout the plume, either for VOCs alone or for VOCs and chromium, as appropriate depending on treatability results.

The selected remedy will include ground-water treatment for an estimated 30 years, during which time the system's performance will be carefully monitored and optimized on a regular basis and adjusted as warranted by the performance data collected during operation. To the extent practicable, EPA will attempt to implement modifications in a way that will accommodate changing land uses and other types of activity. Post-construction modifications to the selected remedy may include any or all of the following:

- at individual wells where cleanup goals have been attained, pumping may be discontinued;

- alternating pumping at wells to eliminate stagnation points;

- pulse pumping to allow aquifer equilibration and encourage adsorbed contaminants to partition into ground water;

- installation of additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.

10.2.1 Ground-Water Contingency Remedy

Based on information obtained during the remedial investigation, and the analysis of alternatives, EPA believes that the selected remedy may be able restore ground water to drinking water quality within a 30-year time frame. However, ground-water contamination may be especially persistent in the immediate vicinity of the source of contaminants, or where concentrations are relatively high. If it appears that the selected ex-situ remedy cannot restore drinking water quality within a 30-year time frame for all or portions of the plume, EPA will evaluate more cost-effective in-situ remedies for implementation. Specifically, EPA will focus on permeable reactive barriers and in-well stripping as potential in-situ contingency remedies.

EPA will also revise its predicted time frame for cleanup if necessary. The ability to achieve cleanup goals at all points throughout the plume will continue to be evaluated as the extraction system is being optimized at the 200 gpm capacity, then modified as necessary, and plume response monitored over time. If the selected remedy cannot meet the specified remediation goals in a cost effective manner at any or all of the monitoring points during implementation, an in-situ treatment technology may be implemented to enhance the effectiveness of the selected remedy in achieving Site goals.

Therefore, while this ROD selects the final remedy for the Boomsnub Soil OU and Site-Wide Ground Water OU, EPA acknowledges that new technologies may become available that could result in a more cost-effective cleanup while ensuring reliable short and long term protection of human health and environment. Consistent with EPA guidance, Superfund Reforms: Updating Remedy Decisions, (OSWER No. 9200.0-22, September 27, 1996), EPA will consider the availability and long-term effectiveness of possible new technologies whenever Ecology and EPA agree to undertake such an evaluation. Such an evaluation will occur at least every five years as part of the five year review. The following Site-specific criteria will be considered, along with the nine NCP criteria, in determining whether to implement an in-situ contingency remedy (e.g., in-well stripping or permeable reactive barriers):

- Is the ex-situ ground-water treatment efficiently removing COCs or have concentrations reached asymptotic levels? Can the treatment system be further optimized?

- Were treatability studies for in-well stripping (IWS) at the Site successful at treating hexavalent chromium? Is IWS expected to reduce contaminants to below cleanup standards or some other level?

- What is the long-term performance of permeable reactive barriers at other sites relative to Site conditions?

- Should in-situ technologies replace, or be used in conjunction with ex-situ ground-water treatment?

Any in-situ contingency measures will, at a minimum, prevent further migration of the plume and include a combination of containment technologies and institutional controls. In implementing the contingency measures, EPA will ensure that the specific application of any in-situ technology is protective of human health and the environment, and is technically practicable. If a contingency remedy is implemented, EPA will document an evaluation of the above criteria, along with the NCP threshold and balancing criteria, in an Explanation of Significant Differences. This document will be made available to the public to explain what actions are necessary to implement the specified contingency remedy at that time.

10.2.2 Rationale for Selected Ground-Water Remedy

To date, the interim pump and treat system has demonstrated its effectiveness at the Site by removing 20,000 pounds of chromium and 1,700 pounds of TCE. EPA expects to achieve cleanup standards over a significant portion of the plume within 20 to 30 years, based on ground-water modeling, by upgrading the existing ex-situ ground-water treatment system from 100 gpm to 200 gpm. Short-term effectiveness (i.e., time to achieve cleanup standards) did not provide a clear means for distinguishing the alternatives. Ground-water modeling predictions estimate that all alternatives would require a similar 20 to 30-year time frame to achieve cleanup standards. The permeable reactive barriers and in-well stripping each have long-term effectiveness components that have yet to be proven under similar site conditions. By contrast, the selected ex-situ ground-water treatment technologies are presumptive remedy technologies identified by EPA as reliable. Because all alternatives involve significant costs, EPA believes it is more cost effective to continue the pump and treat system at this time, rather than implement in-situ technologies where long-term performance is less certain.

10.2.3 Additional Data Collection Needs

EPA has identified additional data collection needs that were not adequately addressed by the data gathered during the RI/FS investigations. The following additional data needs to be collected during the remedial design to increase the understanding of site characteristics in order to refine the predicated cleanup time frames at the Site. First, Site-specific distribution coefficients (Kd values) for chromium are needed from various representative locations in Alluvial aquifer soils and at the Boomsnub Soil OU. This information will be an important aid in understanding the predicted cleanup time frames. This information will be a key input to optimize the ground water extraction system and to assess performance for in-situ technologies like in-well stripping or permeable reactive barriers.

In addition, further vertical profiling (e.g., borehole flow meters, direct push sampling) of the ground-water plume may be necessary to optimize the selected ground water remedy. Other data collection needs may be identified during the remedial design.

10.3 ESTIMATED REMEDY COSTS

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented either in the form of a memorandum in the administrative record file, and Explanation of Significant Differences, or a ROD amendment depending on the significance of the change. EPA's remedy cost estimates are order-of-magnitude engineering cost estimates expected to be within +50 to -30 percent of the actual project cost. For the Boomsnub Soil OU, an estimated 878 cubic yards will be excavated above the action levels at an estimated cost of $364,000. A detailed cost estimate is included in Table 10-1. EPA's selected remedy for the Site-Wide Ground Water OU requires $2.7 million to upgrade the existing ground-water treatment system, and an estimated $14 million over 30 years for continued operation of the ground-water pump and treat system. A detailed cost estimate is provided for the ground-water remedy in Table 10-2.

The estimated cost for the treatability study is $132,000 in capital costs and $121,000 for 12 months of O&M for a total of $253,000. This cost estimate assumes use of the existing in-well stripping well at the Site, plus the addition of three monitoring wells. Capital cost include site mobilization for well drilling, mobile laboratory sample analysis, stripping well equipment package, and granular iron for the gallery. The O&M costs include labor, carbon regeneration and disposal, reductant, vapor phase carbon, reagent media disposal, subcontracting and equipment. This cost estimate was developed from relevant line items in alternative GW7 of the feasibility study. The cost estimate may change as the specific objectives of the treatability study are refined during remedial design and the scope is more clearly defined.

10.4 EXPECTED OUTCOMES OF THE SELECTED REMEDY

The selected remedy will allow the Boomsnub Soil OU to be restored to industrial use. The highest concentrations of chromium remaining in soil will be addressed through excavation. The MTCA Method A soil cleanup standard for lead (1,000 ppm) will be achieved and the site-specific action level in soils of 400 ppm for protection of ground-water will remove the highest concentrations of chromium, significantly reducing the potential for leaching of hexavalent chromium to ground water. Implementation of the selected remedy at the Site-Wide Ground Water OU will reduce risks from a maximum non-cancer risk of 700 at MW-14E and a maximum excess cancer risk of 4×10^{-3} at the same well to a non-cancer risk of 1.0 and an excess cancer risk range of one on one million (10^{-6}). These risks will be reduced by achieving MTCA ground-water cleanup standards or MCLs, as appropriate. TCE generally accounts for the majority of the risk from VOCs. By achieving the MCL for this contaminant, for example, the excess cancer risk will be reduced to 1.26×10^{-6}. To achieve cleanup standards throughout the entire contaminant plume, EPA estimates that it will have to treat 60 million gallons of contaminated water, thereby restoring 37 acres of property impacted by chromium-contaminated ground water and 46 acres of property impacted by TCE-contaminated ground water. Once cleanup standards are achieved, there will be no limits on the available use of ground water.

TABLE 10-1: COST ESTIMATE FOR SELECTED SOIL REMEDY: ALTERNATIVE S5

SOIL EXCAVATION AND OFF-SITE DISPOSAL

CAPITAL COSTS

General	Unit	Quantity	Unit Cost	Total Cost
Site Mobilization and Preparation	LS	1	$10,000	$10,000
Fence Removal and Reinstallation	LF	650	$10	$6,500
Site Survey	HR	16	$150	$2,400
Health and Safety				
Decon Equipment	LS	1	$5,000	$5,000
Health & Safety Expendibles (4 persons X $50/day)	DY	10	$200	$2,000
Analytical	EA	100	$20	$2,000
Air/Noise Monitoring Equipment	WK	2	$500	$1,000
Soil Removal				
Move/Replace Outside System Components	LS	1	$10,000	$10,000
Remove Existing Concrete and Asphalt	SY	380	$10	$3,800
Dispose of Concrete/Asphalt	TON	48	$50	$2,400
Excavate Soil	CY	878	$10	$8,780
Contaminated Soil Hazardous Waste Disposal	TON	1,317	$117	$154,089
Import and Place Backfill	CY	878	$13	$11,414
Replace Asphalt/Concrete	SY	380	$10	$3,800
New Asphalt	SY	2,800	$10	$28,000
SUBTOTAL (DIRECT CAPITAL COSTS)				**$251,183**
Work Plan Development				$25,000
Engineering Design				$15,000
Construction Oversight				$10,000
Contingency Allowance (25% of direct capital costs)				$62,796
TOTAL PRESENT WORTH COSTS				**$363,979**

TABLE 10-2: COST ESTIMATE FOR SELECTED GROUND-WATER REMEDY: ALTERNATIVE GW4

200 GPM PUMP-AND-TREAT SYSTEM

CAPITAL COSTS

	Unit	Quantity	Unit Cost	Total Cost
City of Vancouver				
System Improvement Fee (200 gpm)	LS	1	$1,152,000	$1,152,000
Treatment System Modifications				
New System Building Construction	LS	1	$50,000	$50,000
New Extraction and Treatment System Components	LS	1	$250,000	$250,000
New Effluent Pipeline	FT	7500	$75	$562,500
System Installation Piping and Controls	LS	1	$100,000	$100,000
System Start-Up/Shakedown	LS	1	$30,000	$30,000
New Air Stripper Components	LS	1	$80,000	$80,000
SUBTOTAL (DIRECT CAPITAL COSTS)				**$2,224,500**
Work Plan Development				$25,000
Engineering Design				$100,000
Construction Oversight				$50,000
Contingency Allowance (25% of direct capital costs)				$268,125
TOTAL CAPITAL COSTS				**$2,667,625**

OPERATION AND MAINTENANCE COSTS

CHROMIUM TREATMENT SYSTEM	Unit	Quantity	Unit Cost	Total Cost
Labor				
Project Management	ANNUAL	30	$77,100	$1,185,216
Other Labor	ANNUAL	30	$92,465	$1,421,414
Direct Costs	ANNUAL	30	$12,000	$184,469
Subcontracting	ANNUAL	30	$12,000	$184,469
Waste Disposal	ANNUAL	30	$36,000	$553,408
Monthly Treatment System Sampling	ANNUAL	30	$8,500	$130,666
Biannual Sampling				
Labor	ANNUAL	30	$48,000	$737,878
Supplies	ANNUAL	30	$10,049	$154,478
Acid/Caustic	ANNUAL	30	$4,800	$73,788
Utilities				
Trash	ANNUAL	30	$950	$14,604
Electricity	ANNUAL	30	$10,700	$164,485
Water Disposal Fee (200 gpm)	ANNUAL	30	$224,000	$3,443,429
Media	ANNUAL	30	$90,000	$1,383,521
Equipment and Miscellaneous Supplies	ANNUAL	30	$48,000	$737,878
Monitoring Well Installation	ANNUAL	30	$10,000	$153,725
System Upgrades (once/5 years)	LS	5	$100,000	$255,063
AIR STRIPPING SYSTEM				
Carbon Vessels (new @ 10 year intervals)	LS	3	$13,000	$25,880
Carbon Regeneration/Replacement	ANNUAL	30	$11,000	$169,097
Analytical	ANNUAL	30	$8,000	$122,980
Labor (emergency response, permitting)	ANNUAL	30	$32,000	$491,918

TABLE 10-2: COST ESTIMATE FOR SELECTED GROUND-WATER REMEDY: ALTERNATIVE GW4

Equipment	ANNUAL	30	$10,000	$153,725
SUBTOTAL (DIRECT O&M COSTS)				**$11,742,089**
Administrative Costs (15% direct O&M costs)	ANNUAL	5	$111,835	$484,185
Contingency Allowance (15% direct O&M Costs)				$1,761,313
TOTAL CHROMIUM REMOVAL AND AIR STRIPPING SYSTEM OPERATION AND MAINTENANCE COSTS FOR 30 YEAR REMEDIATON PERIOD				**$13,987,588**
TOTAL PRESENT WORTH COSTS				**$16,655,213**

Present Worth costs calculated assuming annual interest; i = 5%,
and payments made at the end of each year.
Water disposal fee calculated assuming site infiltration gallery not in use.

11.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following section discusses how the selected remedy meets these statutory requirements.

11.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy for the Boomsnub Soil OU, excavation and off-site treatment and disposal of contaminated soils with chromium and lead, will protect human health and the environment through the treatment prior to off-site disposal. Excavating contaminated soils above 400 ppm for total chromium will minimize the potential for leachate generation and recontamination of ground water. The current cancer risks associated with the exposures is in the 10^{-5} to 10^{-6} risk range. The selected remedy will reduce the cancer risks to the 10^{-6} range and the hazard index to less than 1.0, achieving the lower end of EPA's target risk range of 10^{-4} to 10^{-6}. There are no short-term threats associated with the selected remedy that cannot be readily controlled.

The selected remedy for the Site-Wide Ground Water OU, operation of a 200 gpm pump and treat system, will protect human health and the environment through the treatment of chromium and VOCs in ground water by ion exchange and air stripping, respectively. By pumping and treating contaminated ground water, the selected remedy will also prevent the existing plume from migrating beyond its current boundaries at NE 30th, and should prevent contamination from migrating into the Troutdale aquifer where contaminants could impact the CPU drinking water supply well (CPU-7). Current information suggests pumping and treating contaminants at 200 gpm should be adequate to both maintain hydraulic control of the plume at NE 30th Street and remove contamination to federal drinking water standards in an estimated 30-year time period. Cancer risks will be reduced from the 10^{-3} risk range and a non-cancer hazard index as high as 780.

11.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy will be designed and implemented to comply with all action specific, chemical specific, and location specific ARARs identified in this section. The ARARs for the selected remedy are presented below.

Resource Conservation and Recovery Act, 42 U.S.C. §§ 6921-22; 40 CFR Part 261; 40 CFR Part 262 Subparts A, B, C, and D; 40 CFR Parts 264, Subparts I and J; Washington State Dangerous Waste Regulations, WAC 173-303-070, 173-303-170 to -200, 173-303-630

These regulations establish requirements for the proper designation, storage, treatment and disposal of hazardous waste. 40 CFR Parts 261 and 262 and WAC 173-303 apply to the proper designation and characterization of the hazardous waste managed at the Site. There are several types of hazardous waste streams that are now or will be managed at the Site. These waste streams include:

- Chromium and VOC-contaminated ground water and the chromium-contaminated resin and spent carbon used during the ground-water treatment process;
- Filter material used for chromium treatment and spent carbon used to treat air emitted from the in-situ ground water treatment system during the treatability study; and
- Chromium-contaminated soil excavated during the soil remedy.

40 CFR Parts 261 and 262 and the corresponding state Dangerous Waste Regulations are applicable to any hazardous waste generated during the treatment of contaminated ground-water. These regulations require proper designation and characterization of hazardous waste. The selected remedy will comply with these regulations. In addition, 40 CFR Part 264, Subparts I and J are relevant and appropriate for the ground-water treatment portion of the selected remedy. These regulations, as well as the corresponding State Dangerous Waste regulations, require proper use and management of containers (containers are used to store the spent resin prior to off-site treatment and disposal),and require appropriate controls on tank systems. The contaminated ground water will be treated through ion exchange and air stripping with carbon adsorption. The spent resin and spent carbon will be characterized and stored temporarily, as necessary, prior to off-site shipment for disposal or regeneration at a permitted facility. The selected remedy will comply with the substantive requirements for containers, and proper on-site storage of hazardous waste prior to off-site disposal. The selected remedy will also comply with requirements for secondary containment for the tanks on-Site.

The potential waste streams that will be generated from the treatability study include the filter material used to reduce chromium in ground water from hexavalent to the trivalent form and air emissions from the in-situ treatment of the VOCs in ground water. The RCRA and State Dangerous Waste regulations pertaining to air emission standards may be relevant and appropriate to the in-situ air stripping being tested during the treatability study if a closed-loop system is not selected. The air from the air stripping unit will be treated using carbon adsorption. The spent carbon will be properly characterized prior to off-site disposal at a permitted facility. EPA will also properly characterize the filter material prior to off-site treatment and disposal.

40 CFR Part 261 and 262 and WAC 173-303-070 also apply to the chromium-contaminated soil that will be excavated and disposed off-site, if the soil is classified as dangerous, hazardous, or extremely hazardous waste. EPA will meet the federal and state regulations requiring identification, proper handling and disposal of soil identified as hazardous waste.

Model Toxics Control Act, Selection of Cleanup Actions, WAC 173-340-360: Institutional Controls, WAC 173-340-440; Use of Method B Cleanup Standards, WAC 173-340-705; Ground Water Cleanup Standards, WAC 173-340-720; Soil Cleanup Standards, WAC 173-340-740 and 173-340-745

WAC 173-340-360 describes order of preference for cleanup technologies and use of permanent solutions. Section 360 is applicable to the selected remedy and will be demonstrated to be met to Ecology's satisfaction by the State of Washington's concurrence on this Record of Decision. WAC 173-340-440 applies where active cleanup measures will not attain MTCA cleanup levels. In this case, institutional controls, as discussed in Section 10.0, apply to the ground water until ground-water cleanup standards are achieved. WAC 173-340-440, -720, -740, and -745 establish clean-up standards for ground water and soil contaminants and are applicable at this Site. The cleanup standards set forth in Section 7.0, Tables 7-1 and 7-2, of the ROD will meet or exceed these MTCA cleanup standards.

Clean Air Act, 42 U.S.C. § § 7412, 7661(a); General Regulations for Air Pollution Sources, WAC 173-400; Emission Standards and Controls for Emitting Volatile Organic Compounds, WAC 173-490; Ambient Air Quality Standards for Particulate Matter (WAC 173-470), Southwest Washington Air Pollution Control Agency (SWAPCA) Regulations 400 and 490

These regulations prescribe treatment and control requirements for emission to the air and apply to the VOC treatment for ground water. The VOCs in the contaminated ground water are currently, and will continue to be, removed by an air stripping unit. Air stripping removes the VOCs from ground water and transfers them to the air in a gaseous state. The air is then treated using carbon adsorption to remove the VOCs. BOC Gases operates and maintains this portion of the treatment system. BOC Gases obtained a permit from SWAPCA to operate the air stripper prior to the Site being listed on the NPL. Operation of this portion of the treatment system does and will continue to comply with the substantive requirements of WAC 173-400 as implemented by SWAPCA. Further, Washington Emission Standards and Controls for Emitting Volatile Organic Compounds (WAC Chapter 173-490) establishes standards for specific VOC source emissions. These standards establishing emission standards for the air stripping system and the granular activated carbon adsorption unit are incorporated into the permit being met at the Site. Finally, the Ambient Air Quality Standards for Particulate Matter, WAC 173-470 identify suspended particulate standards applicable to excavation activities associated with the soil removal at the Boomsnub Soil OU. These standards will also be met at the Site.

Clean Water Act, 33 U.S.C. § 1317; 40 CFR 403.5; Water Pollution Control Act, RCW 90.48; Water Resources Act, RCW 90.54; Grant of Authority Sewerage Systems, WAC 173-208

These regulations pertain to the off-site disposal of treated ground water, but technically are not an ARAR at this Site. ARARs apply to those actions which occur on-site. Since this is an off-site disposal action, EPA has a permit (Permit # 99-03) for its discharge to the City of Vancouver's wastewater treatment system and will meet the requirements set forth in the permit. EPA will also meet the requirements of 40 CFR 403.5, that prohibit discharges of pollutants into publicly owned treatment works that pass through the facility without treatment or that interfere with the treatment works.

Executive Order 11990, Executive Order for Protection of Wetlands

This Executive Order requires EPA to avoid long- and short-term adverse impacts associated with the destruction or modification of wetlands and avoid direct or indirect support of new construction in wetlands whenever there is a practicable alternative.

Portions of the extraction system (e.g., monitoring and extraction wells and vaults) are either within or adjacent to a seasonal wetland located south of NE 78th Street. The selected remedy includes upgrading and continued O & M of the extraction system. This work may include installation of other wells as necessary. This work may include constructing a small (two foot by four foot) vault around the well. Upgrading as well as O & M of the extraction system is necessary to achieve control of and clean up the ground-water contamination at the Site. While there is no practical alternative to these actions, care will be taken to minimize damage to this seasonal wetland during these activities. Upon completion of cleanup activities, EPA will remove or abandon the wells according to state regulations and make all practical efforts to repair damage to the seasonal wetland caused by the cleanup action.

Migratory Bird Treaty Act of 1918, 16 USC 703-712

This act protects migratory birds and their feathers, nests, and eggs. The Site may be in the pathway of migratory birds. This act may be applicable during construction activities at the Boomsnub Soil OU, where activities may be conducted in proximity to trees or other potential migratory bird habitat.

The Safe Drinking Water Act National Primary Drinking Water Regulations, 40 CFR 141; Public Water Supplies, WAC 246-290

These regulations specify primary standards for drinking water (MCLs). They are applicable at the tap for municipal water supplies; they are relevant and appropriate for the ground water at the Site since both the Alluvial and Troutdale aquifers are used as drinking water supplies. The ground-water cleanup goals for this Site include restoring the ground water to drinking water standards. These standards, identified in Section 7.0 Table 7-2 of the ROD, will be met by the selected remedy.

Pollution Disclosure Act of 1971, RCW 90.52.040

This law requires that wastes are to be provided with all known, available, and reasonable methods of treatment prior to their discharge or entry into waters of the state, and are applicable to the disposal of the treated ground water generated by the extraction/treatment system. The contaminated ground water will be treated, using ion exchange and air stripping, prior to discharge to the City of Vancouver sanitary sewer. This treatment of ground water prior to discharge will comply with the requirements of this Act.

U.S. Department of Transportation 49 CFR Parts 171-180; Transportation of Hazardous Waste Materials, WAC 446-50

These regulations establish requirements for transportation of hazardous materials. These regulations are applicable to transportation of the resin and soil (if hazardous) to off-site disposal facilities and EPA will meet these requirements during its cleanup activities.

Water Well Construction Act, RCW 18.104; Minimum Standards for Construction and Maintenance of Wells, WAC 173-160

These regulations specify requirements for well construction and abandonment intended to protect ground water from contamination. These regulations are applicable to the construction of additional monitoring and extraction wells and the abandonment of any wells at the Site. The construction of new monitoring and extraction wells, and the abandonment of any wells will comply with these standards.

Solid Waste Management-Reduction & Recycling Act, RCW 70.95; Minimum Functional Standards for Solid Waste Handling, WAC 173-304

These regulations establish requirements for the disposal of non-hazardous waste. All non-hazardous waste generated will be disposed off-site in accordance with these regulations. Since disposal occurs off-site, this law and associated regulations technically are not ARARs. Non-hazardous waste generated during the operation of the extraction/treatment system (e.g, waste paper, shipping boxes, etc.), and activities related to the excavation of chromium-contaminated soil (e.g., disposal of soil that is considered non-hazardous) will comply with these regulations.

To Be Considered (TBC)

ARARs are promulgated, enforceable requirements that must be at a Site if they are applicable or relevant or appropriate. Other types of information (e.g., advisories, criteria and guidance) that are not ARARs, however, may be useful and should be considered, as appropriate, if it helps to ensure protectiveness or is otherwise useful in a designing a specific cleanup remedy. This information is commonly referred to as TBCs. The following documents are TBCs at this Site.

Natural Background Soil Metals Concentrations in Washington State, Ecology Publication 94-115

This is a state guidance document providing county-specific background concentrations for inorganic chemicals. Although it is not an ARAR at this Site, it will be considered when comparing site-specific soil concentrations to cleanup standards. Generally, cleanup actions are not required to clean below background concentrations.

Ecology Statistical Guidance for Ecology Program Managers, August 1992 (Ecology Publication 92-54) and Supplement 6.

This document provides guidance for statistical evaluation of sampling data when determining whether MTCA cleanup standards have been achieved. EPA will determine the particular application of this guidance for use at the Boomsnub Soil OU as the sampling and analysis plan is prepared.

11.3 COST-EFFECTIVENESS

In EPA's judgment, the selected remedy is cost-effective and represents a reasonable value for the money spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (NCP Section 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness of this remedial alternative was determined to be proportional to its cost and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the selected remedy is $17.1 million, for both the Boomsnub Soil OU and the Site-Wide Ground Water OU. Although other ground-water alternatives (GW6, and potentially GW5 and GW7) were less expensive, they employed innovative ground-water technologies whose long-term effectiveness is uncertain. In-well stripping has not been proven to treat chromium and permeable reactive barriers have not yet been demonstrated to perform over the thirty-year life span expected to be needed for this Site. EPA believes that the use of the 200 gpm pump and treat system will allow EPA to control the migration of contamination and remove contaminants from areas with higher concentrations. This selected remedy is expected to be cost effective as long as concentrations continue to decline. After source control is implemented at the BOC Gases Soil OU, EPA plans to evaluate the use of the infiltration gallery located on the Boomsnub Soil OU to make this alternative even more cost effective.

11.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and a bias against off-site treatment and disposal and considering State and community acceptance. These determinations are described in section 9.0, and summarized in sections 10.1.1 and 10.2.2, where EPA's Rationale is provided for the selected remedy components. Ground water is treated through extraction and ex-situ treatment via ion exchange and air stripping. The selected remedy satisfies the criteria for long-term effectiveness by selecting EPA's presumptive remedy for ex-situ ground-water treatment. An evaluation of in-situ treatment technologies will also be considered no less often than every five years in the event that pump and treat reaches the point at which it can no longer effectively reduce contaminant concentrations. An in-situ ground-water treatment may be considered by if EPA determines it is appropriate for the Site.

11.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy will excavate and treat, if necessary, hexavalent chromium in soil which continues to serve as source material at the Boomsnub Soil OU and that constitutes the remaining principal threat at this Site. As a result significant reductions in the highest concentrations of hexavalent chromium in soils will be achieved, and the localized areas of lead found in soils will also be excavated for off-site disposal. Because the selected remedy will excavate and stabilize the contaminated soils, if necessary, prior to off-site disposal, and provide ex-situ treatment of the contaminated ground-water, the CERCLA preference for treatment as a principal element is satisfied at this Site.

11.6 FIVE-YEAR REVIEW REQUIREMENTS

Because this remedy will result in contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

12.0 DOCUMENTATION OF SIGNIFICANT CHANGES

No fundamental changes were made from the Feasibility Study and proposed plan to this Record of Decision. However, several clarifications have been made that answer questions raised by interested parties. These clarifications are primarily based on information that exists in the RI/FS and Administrative Record for this Site. The following explanations for various conclusions are provided.

Identification of COCs

The risk assessment evaluated several chemicals of potential concern in soil and ground water based on the most conservative exposure scenario (future residential exposure) and the most conservative ARAR (generally the MTCA Method B ground-water cleanup standard). Subsequent to the baseline risk assessment, EPA confirmed that the land use of the property comprising the Boomsnub Soil OU is zoned for light industrial use. Consistent with EPA's guidance "Land Use in the CERCLA Remedy Selection Process" (OSWER Directive 9355.7-04, dated May 25, 1995), EPA's remedial action objectives and remediation goals have been established to be consistent with this future industrial use, rather than the more conservative residential use. It is unlikely based on zoning and longstanding historical uses of the property that residential uses would occur at the Boomsnub Soil OU.

For the Site-Wide Ground Water OU, 27 COPCs were identified, as explained in Section 6.0. Subsequent to the risk assessment and feasibility study, EPA refined this list of COPCs by eliminating contaminants that were either below background concentrations or were not detected above ground-water cleanup levels during the 1997 biannual sampling round. This resulted in the list of COCs that is presented in Section 7.0, Table 7-2.

Feasibility Study Cost Estimates

The Feasibility Study estimated the cost of ground-water alternatives using two basic assumptions that were not explicitly identified. The first implicit assumption is that the in-situ treatment technologies (in-well stripping and permeable reactive barriers) are uncertain in their long-term performance. To accommodate this uncertainty, the ground-water alternatives for these technologies were paired with traditional pump and treat (alternatives GW5 and GW7). Pairing in-situ technologies with pump and treat creates what EPA believes are the most realistic scenarios for implementing these technologies given the uncertainties. Using this approach results in anticipated cost savings from in-situ treatment being obscured by the added ex-situ ground-water pump and treatment costs for GW5 and GW7. In response to comments received during the public comment period, EPA recalculated the cost estimate for GW5 assuming ground-water reinjection up gradient of the PRB, instead of ex-situ treatment. By removing the ex-situ pump and treat costs but adding wall replacement costs at 10-year intervals, the cost for GW5 based on a 30-year time frame changes from $19.2 million to $10.6 million, substantially reducing the cost. EPA still believes, however, that the analysis of alternatives presented in the Feasibility Study provides what is currently the most realistic scenario for implementing the in-situ technologies. Although costs can change as described here, the same evaluation based on the implementability and effectiveness criteria applies. Because the rationale for EPA's selected remedy relied more on these other criteria, the cost assumptions explained here do not alter EPA's basis for the selected remedy.

The second assumption used in preparing cost estimates for the ground-water alternatives was the estimated time to achieve cleanup objectives. Three different factors were considered. First, historical trends of the influent/effluent data from the existing pump and treatment system were projected on a linear scale to predict the time needed to achieve cleanup objectives for chromium and TCE. The result was an estimated five years for chromium and ten years for TCE to achieve cleanup standards. The second factor considered was the ground-water modeling used, which predicted cleanup time periods of 20 years to reduce COCs throughout the majority of the contaminant plume. The third factor considered was a standard 30-year time period, which represents the maximum time period that can reasonably be calculated for meaningful present worth cost estimates. The use of the influent/effluent data has little predictive value, and is not considered reliable by EPA. The accuracy of ground-water modeling is limited to predicting relative time periods for cleanup, and may not meaningfully distinguish between 20 and 30 years. As a result, EPA chose to rely on the most conservative 30-year time period for estimating the cost of the selected remedy. Optimization of the ground-water treatment system during remedial design and remedial action will be used to refine the accuracy of the predicted cleanup time periods.

Finally, as explained in Section 8.2.4 and Table 9-2, the total present worth cost for GW4 was incorrectly stated as $14 million in the FS and proposed plan. As a result of an omission in the FS report the capital and O&M costs were not totaled during the report preparation.

Alternative Disposal Options for Treated Ground Water

As part of the Feasibility Study EPA evaluated the use of an existing infiltration gallery that was installed on the Boomsnub property at the time of the soil removal in 1994. Based on a one week test, EPA concluded that the infiltration gallery has capacity for approximately 100 gpm, without adverse impact on the down gradient plume. However, the one week test also confirmed there is potential for ground-water mounding to occur, which could divert up gradient VOCs in ground water coming from BOC Gases. If the infiltration gallery were used before source control measures are put in place at the BOC Gases property, the contaminant plume could spread laterally to the north and south. For this reason, EPA will not consider use of the infiltration gallery until source control actions are in place at the BOC property. Once this occurs, EPA intends to evaluate the use of the infiltration gallery to reduce water disposal costs associated with sending treated ground water to the City of Vancouver POTW. If EPA determines that it is appropriate to use the infiltration gallery, this action will be documented in a memorandum to the administrative record file. Any additional ARARs associated with using the infiltration gallery or other disposal options will be evaluated and documented at that time.

Appendix A
Boomsnub/Airco Superfund Site
Record of Decision

RESPONSIVENESS SUMMARY

This responsiveness summary describes the oral and written comments received during the public comment period for the Boomsnub Soil and Site-Wide Ground Water OUs at the Boomsnub/Airco Superfund Site. Four written comments were received and two oral comments were provided. Of those comments received, one commentor provided comments both orally and in writing. All comments received are summarized below, with EPA's response.

<u>Stakeholder Issues and EPA Responses</u>

Dan Heuvel represents Heuvel Enterprises, L.L.C., which is the property owner of a parcel north of the Boomsnub Soil OU and north of the Lewis and Clark Railroad. EPA's soil sampling investigation extended to this property and EPA has monitoring and extraction wells on the Heuvel property. Mr. Heuvel submitted written comment.

Comment: Mr. Heuvel expressed support for EPA's selected remedy.

Response: Comment noted. Community involvement is important to EPA and community acceptance is an important criterion in EPA's selection of the remedy.

Doug Ballou represents the NE Hazel Dell Neighborhood Association. Mr. Ballou attended EPA's public meeting on the Proposed Plan and provided oral comment on EPA's preferred alternative.

Comment: Mr. Ballou expressed support for EPA's preferred alternative (selected remedy).

Response: Comment noted. EPA appreciates the community involvement from the NE Hazel Dell Neighborhood Association.

The Bonneville Power Administration (BPA) owns property along NE 30th Avenue that has been impacted by the ground-water plume. BPA submitted the following written comment.

Comment: BPA is supportive of the selected remedy, specifically citing the preference for the selected remedy over the permeable reactive barrier wall (GW6) due to difficulties anticipated with installing a second wall near the transmission lines located near NE 30th Avenue. The commentor cited health and safety concerns and concerns about impacts to the property from construction associated with the barrier wall.

Response: The commentor's concerns were factored into EPA's analysis of alternatives under the implementability and short-term effectiveness criteria. Because the permeable reactive barrier technology is a new technology (implemented only in the past 5 years), EPA is hopeful that techniques for implementing this technology will improve over the next several years as more experience is gained in installing barrier walls at other sites. For this reason, EPA has retained this technology as a potential contingency remedy that may increase the effectiveness of treating contaminants at the Site if the ex-situ ground-water treatment reaches a point where it is no longer effective. However, at this time, EPA agrees with the commentor that the ground-water treatment system is more easily implemented than the permeable reactive walls.

BOC Gases, a potentially responsible party at the Site, has participated in EPA's investigation and cleanup activities to date. BOC is currently performing an investigation of the BOC Gases Soil OU under an administrative order on consent with EPA's oversight. BOC submitted several specific comments with respect to EPA's preferred alternative as presented in the Proposed Plan. BOC presented essentially the same comments both orally and in writing. Each of BOC's comments and EPA's responses are provided below. The following comments are summarized just as they were submitted in writing by BOC Gases. Page references are to the Proposed Plan.

Comment: Page 5, PRG Table. For 1,1-DCE, why is the MTCA Method B cleanup level used and not the MCL?

Response: The PRG Table in the Proposed Plan has been replaced by Table 7-2 in the ROD. EPA has set the cleanup standard for 1,1-DCE in accordance with the MTCA Method B cleanup level because it has been identified as an ARAR for the Site. The cleanup standard for 1,1-DCE that is specified in Washington State's MTCA statute is both applicable and more stringent than the federal MCL. In choosing cleanup standards for this and other sites in Washington State, EPA selects the MCL as the cleanup standard in those instances when the risk calculated under the MTCA equates to less than 1×10^{-5}. When the calculated risk at the MCL equates to a risk greater than 1×10^{-5}, the MTCA Method B-listed value is the cleanup standard used. However, since the MTCA B value for 1,1-DCE is below the PQL, the PQL value of 1 ug/L was listed as the remediation goal in Table 7-2 of the ROD, consistent with Ecology guidance.

Comment: Page 5, PRG Table. For cis 1,2 DCE, the highest concentration listed for this compound is 78.6 µg/L, which is 11% above the PRG (70 µg/L). For all other compounds that exceed the PRG, is the exceedance less than 11%? If not, why were these compounds not included in the PRG table? BOC requests the opportunity to comment on all other compounds that will have a remediation goal identified in the ROD.

Response: The chemical cis-1,2-DCE was correctly listed as a chemical of concern since it exceeds the cleanup standard, but it was erroneously listed in the PRG table as one of the "primary" contaminants at the Site. As noted by BOC, cis-1,2-DCE does exceed the cleanup standard of 70 µg/L. All VOCs exceeding MCLs or applicable MTCA Method B cleanup standards (identified in Table 7-2 of this ROD) are part of the remediation goals for this Site. EPA has provided BOC Gases an opportunity to review the list of COCs in Table 7-2 of the ROD, as requested.

Comment: How does the Proposed Plan and ultimately the ROD take into consideration possible changes in cleanup criteria, such as the potential change to the TCE MCL? If MCL and/or MTCA cleanup level[s] change will the ROD have to be amended to incorporate the change?

Response: The NCP at 40 CFR 300.430(f)(1)(ii)(B)(1) states that: "Requirements that are promulgated or modified after ROD signature must be attained (or waived) only when determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment." In the case of a change to the MCL (making it more or less stringent) for TCE or another chemical of concern, EPA would evaluate whether the new standard was still protective (i.e., within EPA's acceptable risk range). This review would occur no less of the than at each five-year review required for the Site (described in Section 11.6 of this ROD). If EPA determined that a change to the ROD was necessary, EPA would document this change either in a ROD amendment, an Explanation of Significant Differences, or a memorandum to the administrative record file. The determination of the appropriate method of documenting the change would be made at the time of the change, since such a change would likely impact a number of Superfund Sites. Similarly for MTCA cleanup standards, under WAC 173-340-720 (2)(b) & (c), Periodic Reviews, new scientific information for individual hazardous substances or new ARARs are considered during the 5-year review.

Comment: Page 6, GW-4 200 gpm pump-&-treat system "would be designed with a 200 gpm capacity." Question - will 200 gpm be the system capacity or will the system be designed and built with the potential for increased water flow rates?

Response: Based on the ground-water modeling, EPA expects that 200 gpm will be adequate to achieve the remedial action objectives for the Site. However, during the remedial design, EPA will ensure that the system can comfortably handle the 200 gpm flow rate to minimize treatment plant down time that has been experienced with the 100 gpm treatment system. EPA will also factor in limitations of ground-water modeling to predict the necessary flow rate with precision.

Comment: Page 6, GW-4. There are several potential water disposal alternatives other than the POTW. The ROD should allow for alternative disposal methods or will implementation of one or more alternate disposal methods require a ROD Amendment?

Response: Although not explicitly described in the Proposed Plan, the Feasibility Study did evaluate use of the infiltration gallery on the Boomsnub Soil OU. As described in Section 12.0 of the ROD, the infiltration gallery may be evaluated for use to dispose of a portion of the treated ground water once the up gradient source of VOCs is controlled. Use of the infiltration gallery would require compliance with state ARARs and acceptance by the Washington State Department of Ecology. In addition, if a contingency remedy is implemented that includes in-situ technologies, then the need for water disposal would be eliminated or reduced. Therefore, EPA acknowledges that other potential discharge, such as the infiltration gallery, could be implemented, but implementation would likely require documentation in a memorandum to the administrative record file documenting the change.

Comment: Page 7, GW7. It is not clear that the in-well-stripping (IWS) technology is an in-situ process, which is one of the greatest strengths of this technology. Please make this clear.

Response: EPA acknowledged in the Proposed Plan meeting that IWS is an in-situ process. This has also been clarified in the description of alternatives (Section 8) of this ROD.

Comment: Page 9 Table 2. The description of GW7 states chromium removal was not effective. Since chromium was effectively reduced within the pilot test well this statement overstates the findings of the pilot test. It is EA's understanding from a discussion with the EPA staff in Ada, OK, that chromium removal was not observed in the aquifer because the pilot test did not reach steady state.

Response: EPA does not believe that the description of GW7 has been overstated given the results of the pilot test referenced by BOC Gases. Various explanations were offered for why chromium removal was not observed in the aquifer within the anticipated area of influence.

Even if the pilot test did not reach steady state, predictions from the technology vendor, Project Performance Corporation, were that the pilot should have approached steady state given the time period it was operated. Another hypothesis offered by Project Performance Corporation was that significant VOCs and chromium may remain sorbed to aquifer soils which increases the number of pore volumes and treatment time periods required to reduce contaminant concentrations. Another complicating factor was the unexplained discrepancies between field and lab analysis of chromium at various monitoring points, which calls into question even the reductions of chromium in the pilot test well. For these reasons, EPA does not believe that the statement "chromium removal was not effective" is an overstatement.

Comment: Page 11, Cost Table. GW5 and GW6 do not appear to include wall replacement costs. This is a significant omission because the cost of these alternatives is dominated by the wall construction (capital) costs.

Response: BOC's observation is correct that GW5 and GW6 as shown in the Proposed Plan do not include replacement costs. To address BOC's comment, EPA recalculated the cost of these alternatives with wall replacement costs factored into the total cost. The capital cost for two complete wall replacements were assumed, allowing for wall replacement at 10-year intervals. EPA assumed the cleanup would take 30 years to achieve. Based on this analysis, the total cost of alternative GW5 would increase from $19.2 to $22.5 million and GW6 would increase from $11.5 to $18.4 million, an increase of approximately $6.9 million. EPA notes that these revised costs may be overestimates because complete wall replacement may not be necessary. It may be that only the central portion of the wall, where the highest contaminant concentrations are located, needs to be replaced. BOC's observation that costs for GW5 are dominated by wall replacement costs is contradicted by the BOC's next comment that the costs are driven by the pump and treat. The latter observation is more accurate. By removing the ex-situ pump and treat costs, but adding wall replacement costs at 10-year intervals, the cost for GW5 over a 30-year time period changes from $19.2 million to 10.6 million, substantially reducing the cost.

Comment: Page 11, Cost Table. This table shows that the costs for GW5 are driven by the use of pump and treat for a portion of the plume, a cost that is part of GW7 too. A pure IWS alternative would likely cost less than all the alternatives presented. While BOC and EA are aware of the time and contracting constraints on completing the FS, a pure IWS alternative should have been included for the proposed plan.

Response: Approximately 56% of the cost of GW5 are associated with continuing ex-situ pump and treatment at 100 gpm, accounting for $12.7 million of the estimated total cost of alternative GW5 under the 30-year cleanup time frame. The cost of constructing a permeable reactive barrier (PRB) under GW5 is $3.5 million, plus O&M costs of $6.3 million ($3.3 million for replacement and $3.0 million for monitoring) for a total of $9.8 million for the PRB without pump and treat, or $22.5 million for one PRB with pump and treat at 100 gpm. EPA did not consider a "pure" in-well stripping alternative (i.e., use of in-well stripping to treat the entire ground-water plume) first and foremost because in-well stripping has never been successfully used at a site to treat chromium. The four month treatability study conducted at the site for in-well stripping modified for chromium treatment also did not provide convincing evidence that chromium can be treated in the aquifer using this technology. This one implementability concern alone made in-well stripping an unrealistic alternative to for consideration as a stand-alone technology. Pairing in-well stripping with pump and treat was the only viable means of considering this in-situ treatment technology given the current implementability constraints.

Comment: Page 12, paragraph 2. The results of the soil investigation are limited in determining sources of chromium in the ground water. It would be appropriate to have ground-water data from 8 to 10 geoprobes on the Boomsnub property to determine where the soil sources are [located].

Response: EPA believes that the 300 total chromium soil samples, 32 hexavalent chromium soil samples, and three leach tests taken from representative sample locations at the Boomsnub Soil OU are sufficient to identify where the remaining sources of soil contamination are located. EPA does not believe that the recommended ground-water data is necessary to further refine the extent of soil contamination at this OU.

Comment: Page 14, PRG Table. The 400 ppm for Cr in soil seems high. How was this number determined? Has Ecology agreed to this combined cleanup standard?

Response: Yes, Ecology has agreed to a Site-specific remediation level of 400 ppm for total chromium and a MTCA soil cleanup standard protective of ground water of 8 ppm for hexavalent chromium. The 400 ppm remediation level for total chromium is a site-specific value selected by EPA to remove the highest concentrations of total chromium remaining in soils at the properties. This number was selected, as explained in sections 7.0 and 10.0, with the understanding that EPA will rely on the selected ground water remedy to treat hexavalent chromium in soils at concentrations between the 8 ppm cleanup standard and the 400 ppm remediation level. In selecting the remediation level, EPA considered cost as one factor. To remediate soils to the 8 ppm MTCA cleanup standard would have cost exceeded an estimated $1.7 million, which EPA does not consider cost effective. In choosing a remediation level higher than the 8 mg/kg cleanup standard, EPA selected 400 ppm as a natural break in the cost curve. Although EPA considered selecting 116 mg/kg as another cost break point in the feasibility study, EPA chose the higher 400 mg/kg remediation level because the available data did not show an increased benefit in selecting 116 mg/kg over the 400 mg/kg remediation level.

Comment: Page 15 Alt S-5. This alternative states that "this action level would reduce surface exposures to safe levels for residential use." However, the Human Health Risk as explained on page 12 is based on a commercial/light industrial use scenario. BOC and EA assume the residential exposure risk numbers are high. Should they be used or not?

Response: EPA evaluated the human health risks for both residential and industrial exposures as shown on Table 6-1 and 6-2, but EPA's Remedial Action Objectives identified in Section 7 are based on a future industrial use scenario. The residential exposure assumptions are not used to determine the need for action at the Boomsnub Soil OU. The remediation level for lead in soils is based on the MTCA Method A industrial soil cleanup standard of 1,000 ppm. The remediation level for chromium in soils is 400 ppm (see comment above). The remediation level for total chromium coincidentally corresponds to the hexavalent chromium MTCA Method B soil cleanup standard for residential use. However, the remediation level was chosen to remove the highest concentrations of chromium remaining in soil, and not to ensure that the property will be available for residential uses, although that may be the result.

Comment: Page 16 Compliance with ARARs table. Soil flushing with City water would reduce the cost of soil flushing because the underground injection control would not be triggered. Would using treated water through a sprinkler system eliminate the injection control issue? Was a cost benefit analysis conducted to establish that the cost of the additional operation of the pump and treat system that is required by the preferred alternative is less than the cost of soil flushing. BOC and EA think this cost/benefit analysis should be conducted to clearly establish the cost advantage of the preferred alternative.

Response: The underground injection control was not specifically factored into the cost of the soil flushing alternative because it is not considered by EPA to represent a significant cost item for that alternative. A cost benefit analysis was not conducted to evaluate the additional operation costs of the pump and treat system required by the preferred alternative (soil excavation). Although EPA did not conduct such an analysis, if such an analysis were conducted, EPA expects the cost of soil flushing would be greater than the cost of the soil excavation alternative because excavation removes the highest concentrations of contaminants while soil flushing places a greater burden on the pump and treat system for treatment of chromium flushed to ground water. In any event, EPA does not believe the recommended cost/benefit analysis is necessary. EPA considers the estimated capital cost of the two alternatives to be comparable ($364,000 for excavation versus $393,000 for soil flushing). As explained in Section 10.0, the rationale for selecting soil excavation was the short-term effectiveness criterion that is, the time until the RAOs are achieved, rather than cost. Removing the highest concentrations from acting as an ongoing source is preferable to flushing contaminants into ground water over an estimated 2-year period.

Comment: Page 19, paragraph 2. Why is IWS limited to hot spot treatment? If additional pilot study shows this technology works, why couldn't it be phased in site wide? Also, if the Cr is cleaned up before the VOCs, IWS could not be implemented site wide as written. Clearly this is a new application for this technology, but let's not limit its application here if it is shown to be effective in the future.

Response: EPA will consider broader use of in-well stripping than "hot-spot" treatment if it is determined to be appropriate for the Site. In Section 10 of this ROD, EPA has clarified the criteria under which in-well stripping can be implemented. As explained in the contingency remedy description, EPA will consider broader implementation of in-well stripping at the Site based on the results of expanded treatability studies conducted during remedial design, on the performance of the pump and treat system over time, and other relevant factors.

The following additional comments were provided by BOC Gases via oral comment at the public meeting on August 17, 1999. Comments provided in writing and orally are not repeated here. Page and figure references in the comments refer to EPA's proposed plan dated August 6, 1999. The comments below are paraphrased from the original transcript.

Comment: Page 3, Figure 1: The concentration contour for the cleanup standard is listed as the MTCA Method B Cleanup Standard (3.98 ug/L) is different than page 5 under Summary of Preliminary Remediation Goals, where the preliminary remediation goal for TCE is listed as 6 parts per billion and the MCL. BOC requests clarification on which cleanup standard applies.

Response: EPA has clarified in this ROD that the applicable cleanup standard for TCE is the federal MCL of 5 ppb. This clarification is reflected in Figures 5-5 and 5-7 of this ROD, and in Table 7-2. As shown in Table 7-2 of the ROD, the MCL is the cleanup standard unless the risk as calculated by MTCA is greater than 1 x 10^{-5}. In those instances where the risk is greater than 1 x 10^{-5} at the MCL, the MTCA Method B calculated cleanup standard is the applicable cleanup standard.

Comment: Page 5, Summary of Preliminary Remediation Goals, the PRG for 1,1 DCE, which is a breakdown product of TCE, is listed as 0.07 ppb and it lists the source of the PRG as the MTCA method B for residential. Why is the MTCA Method B standard cited instead of the MCL, which is 0.7 (a factor of 10 difference)? Also, it is impractical to think a pump and treatment system, regardless of the extraction rate, will be able to achieve a treatment standard of 0.07 ppb for [1,1-DCE]. There is also a limiting factor in laboratory quantitation limits (e.g., Method 8260 has a practical quantitation limit (PQL of 1.0 for 1,1 DCE).

Response: The MTCA Method B ground-water cleanup value is listed in the PRG table because the calculated risk at the MCL as calculated by MTCA is 9.6 x 10^{-5}, which exceeds MTCA's 1x10^{-5} acceptable excess carcinogenic risk threshold. The MTCA B calculated value (0.0729 ppb) is the applicable cleanup standard. However, because the MTCA B cleanup standard is the below the practical quantitation limit (1 ppb) for 1,1-DCE, the PQL becomes the cleanup standard, as specified in MTCA. Therefore, in Table 7-2 of this ROD the cleanup standard has been changed from 0.07 as listed in the proposed plan PRG table to 1.0, which is the PQL. With respect to the pump and treatment system, EPA believes that the cleanup standard of 1.0 may be achieved at this Site. However, if ground-water monitoring data demonstrate that this cleanup standard cannot be achieved through ex-situ pump and treat technologies, EPA may implement a contingency in-situ treatment technology or invoke a technical impracticability waiver. Any consideration of a technical impracticability waiver would be consistent with EPA's "Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration" (Interim Final, 9234.2-25, September 1993) or any superceding guidance.

Comment: Page 7, under Alternative GW7, VOCs will not necessarily be classified as a hazardous waste, which impacts the cost estimate for disposal.

Response: BOC's statement concerning impacts to the cost estimate for disposal is not entirely correct. As identified in section 11.2, compliance with ARARs, VOCs may likely be a hazardous waste. EPA believes it is appropriate to estimate the cost of alternative GW7 assuming that VOCs captured via carbon adsorption will be a hazardous waste. In any event, this assumption does not materially affect the cost estimate for the alternative because the cost for carbon regeneration/disposal over 30 years is $169,097 (Table C6 in Feasibility Study) associated with the air stripper component of ex-situ ground-water treatment. The estimate for 30 years of carbon regeneration/disposal associated with the in-well stripping system is $307,779. Together, EPA's disposal cost estimate total $476,876, which accounts for only 2.5% of the total $19,230,691 present value cost for alternative GW7. Given that the required accuracy of EPA's cost estimates are +50/-30%, it is immaterial whether the disposal costs for VOCs under alternative GW7 are assumed to be hazardous or non-hazardous.

Comment: Page 6, regarding the permeable reactive barrier, why isn't reinjection of the treated water being considered for GW5 or GW7, where both are combined with the 100 gpm ex-situ ground-water treatment system?

Response: As explained in Section 12.0, the Feasibility Study estimated the cost of ground-water alternatives using two basic premises. The first premise is that the in-situ treatment technologies (in-well stripping and permeable reactive barriers) are uncertain in their long-term effectiveness at similar sites. To accommodate this uncertainty, the ground-water alternatives for these technologies were paired with traditional pump and treat (alternatives GW5 and GW7) to create what EPA believes would be the most realistic scenarios for implementing these technologies given the uncertainties.

EPA did not consider reinjection of the treated water under GW5 or GW7 because of the uncertainty associated with the long-term performance of the PRB at depth and the lack of evidence that in-well stripping can be modified to treat hexavalent chromium. Modifying alternatives GW5 and GW7 to include reinfiltration instead of ex-situ ground-water treatment would only increase the burden on these technologies over the long term by expanding the use of the technology. This would be contrary to EPA's original premise, and only increase the uncertainty of the long-term effectiveness of the alternative as a whole.

Comment: The cost of the Site-Wide ground-water alternatives should be displayed in their component parts to allow an "apples-to-apples or linear" comparison (e.g., PRB alone, PRB plus GW3, PRB plus reinjection and similarly for in-well stripping).

Response: EPA believes it is more appropriate to display costs for the alternative as a whole rather than for each of the component parts as suggested in the comment, because the alternatives assembled by EPA represent viable alternatives for assessment by the nine NCP criteria considering cost, effectiveness, and implementability. To represent the component parts of the alternatives as suggested (e.g., PRB or in-well stripping alone and then PRB or in-well stripping with 100 gpm) would inaccurately display an alternative that is not viable at the Site given available information. For the PRB example given in the comment, EPA recalculated the cost estimate for GW5 (one PRB with 100 gpm pump and treatment) assuming ground-water reinjection up gradient of the PRB, as suggested in the comment above. By removing the ex-situ pump and treat costs but adding wall replacement costs at 10-year intervals as suggested in a separate comment, the cost for GW5 over a 30-year time frame changes from $19.2 million to $10.6 million, substantially reducing the cost. The pump and treat alternative accounts for $12.7 million of the estimated total cost of GW5. The cost of constructing a permeable reactive barrier under GW5 is $3.5 million, plus O&M costs of $6.3 million ($3.3 million for replacement and $3.0 million for monitoring) for a total of $9.8 million for the PRB without pump and treat, or $22.5 million for one PRB with pump and treat at 100 gpm. Although this cost difference is substantial, uncertainties with long-term effectiveness of one PRB would be magnified when paired with reinfiltration because the single PRB would need to treat the entire plume, instead of half as in the PRB with 100 gpm pump and treat.

Comment: Page 6, GW5, states that iron would be placed in a 20-foot thick zone at 50 to 70 foot thick zone below ground surface. However page 4, under nature and extent of contamination, says the highest levels of chromium are generally found from 70 to 100 feet below ground. Please clarify this apparent inconsistency. Exactly where would the iron be placed for the permeable reactive barrier?

Response: Both references in the proposed plan are correct. The 50 to 70 foot zone referenced in GW5 refers to the central portion of the ground-water plume. The 70 to 100 foot depth refers to the western edge of the ground-water plume. The iron would be placed at different depths to intercept the ground-water contamination, since the depth of contamination varies at different locations in the ground-water plume. For GW5, one wall would be placed near the center of the ground-water plume, where the aquitard is the highest. At this location the wall would likely be placed at an interval of 50 to 70 feet below ground surface. For GW6, a second wall at the western edge of the ground-water plume would be placed deeper, at 70 to 100 feet below ground surface, because the ground-water contamination is deeper in this area.

Comment: Page 8, GW7, states that GW7 has been proven for cleanup of VOCs but not for treatment of chromium, and also that the in-well stripping technology is less proven than pump and treat technologies at providing hydraulic containment. Please clarify that in-well stripping is not a containment technology.

Response: In-well stripping is generally designed to treat contaminants as they pass through the circulation cell created by the in-well stripping well, so that as ground water leaves the circulation cell the contaminants have been removed. However, depending on factors such as the design specifications (e.g., number and spacing of wells) and the site conditions (e.g., up gradient ground-water contaminant concentrations, and adsorption coefficients in aquifer soils) the in-well stripping technology may or may not be able to reduce contaminant concentrations to below cleanup standards as ground water leaves the circulation cell down gradient of the in-well stripping well(s).

Another aspect of applying in-well stripping and other technologies to site remediation is the overall strategy for implementing the technology. At the Boomsnub Site-Wide Ground Water OU, EPA has identified two remedial action objectives: plume control, and achieving ground-water cleanup standards. At the western edge of the ground-water plume, plume control is a key part of EPA's strategy for this Site. This is currently being managed through ex-situ ground water treatment and extraction wells. The wells serve to hydraulically prevent contaminants from migrating beyond the Site, while the ion-exchange and air stripper treatment train treats the contaminants. In the Site strategy, ex-situ ground-water treatment has both a hydraulic containment component and a treatment component. The same would be true of the in-well stripping technology if it were applied at the leading edge of the plume. So, while it is technically true that in-well stripping is not a containment technology, the Site strategy includes providing hydraulic containment at the leading edge of the ground-water plume to prevent contaminants from migrating further west. EPA distinguishes between the Site strategy, which entails preventing further migration of contaminants ("containment") and technology design, which is the mechanism employed by a technology with respect to addressing contamination. For the Site strategy, the IWS wells would be used to treat contaminants in the eastern half of the plume and "contain" or prevent further migration of contaminants down gradient.

Comment: Page 9, compliance with ARARs, states that GW5 and GW6 are proven to meet ARARs for VOCs, but chromium is not mentioned. Does the reactive wall treat for chromium? Also, a statement should be included that GW5 must rely on the existing pump and treat system to the west to meet ARARs.

Response: Yes, the reactive wall treats chromium by reducing chromium from the hexavalent to the trivalent form. The trivalent chromium binds with the iron in the permeable reactive barrier. Regarding GW5, EPA has modified section 9.2.2 to clarify that GW5 would rely on the existing pump and treatment system to meet ARARs for the western half of the ground-water plume.

Comment: Page 9, long-term effectiveness, states that GW7 was not effective for chromium removal [in the four-month treatability study conducted at the Site]. The tests did show that chromium removal did occur. Does EPA feel chromium removal could be effective given a longer test period?

Response: The commentor states that chromium removal did occur during the four-month treatability study conducted during the FS. As a matter of clarification, the chromium removal was evident only within the stripping well and not in the nearby monitoring wells which are more appropriate indicators of removal of hexavalent chromium in the aquifer. For this reason, EPA is uncertain whether chromium removal will be effective given a longer test period. The 12-month treatability test to be conducted during implementation of the selected ground-water remedy is intended to resolve this uncertainty.

Comment: Page 10 and 11, implementability, a statement should be included for GW7 that no water handling is required outside the well, so it is much more easily implemented than GW4.

Response: Section 9.2.6 of the ROD does include a statement that GW7 may be more easily implemented, assuming the pilot study results demonstrate that TCE and chromium at the Site can be treated to achieve cleanup standards. Until then, GW7 is not considered more easily implementable because the technical feasibility has not been proven at similar sites, which is a key component of the implementability criterion.

Comment: Page 15, S5 (soil excavation), couldn't an additional irrigation system be beneficial in addition to soil excavation, to expedite the migration of any remaining chromium in soils to ground water, which otherwise might require the same time frame for remediation as the 20 to 30 year prediction for ground water cleanup? Also, leaving some chromium in soils will increase the O&M of the ground water monitoring system.

Response: EPA does not see the need for an additional irrigation system to facilitate infiltration of remaining hexavalent chromium in soils after soil excavation is complete at the 400 ppm remediation level for total chromium. As part of EPA's ongoing ex-situ ground-water extraction strategy, EPA intends to control the migration of chromium from the Boomsnub Soils OU by manipulating the extraction rates of nearby extraction wells (PW1B and others). This will allow the down gradient ground-water plume (e.g., west of St. Johns Avenue) to be managed by the ex-situ ground-water treatment without additional impacts of hexavalent chromium from the Boomsnub Soil OU. With respect to the associated O&M cost, EPA does not believe the ground-water O&M costs will be significantly increased by the infiltration of residual hexavalent chromium that is not excavated by the 400 ppm remediation level. In effect, these cost have already been factored into the existing estimates for GW4 (see Table 10-2) operating at 200 gpm because the GW4 alternative assumes that nearby extraction wells will be operating and EPA's optimization strategy will factor in controlling migration of contaminants from the Boomsnub Soil OU. EPA does not anticipate that additional wells will be required to control the down gradient migration of contamination from the Boomsnub Soil OU. However, EPA estimates that of the $14 million in O&M cost of GW4, approximately $376,227 could be attributed to O&M for S5 (see EPA's response to the final comment below).

Comment: Page 16, compliance with ARARs, states that S3, S4, and S5 will comply with ARARs (MTCA soil cleanup standards). However, S3 does not meet the ARAR because the contamination remains. Simply capping, as described in S3, does not achieve the number value identified in the MTCA cleanup standards. Therefore, S3 does not meet the ARAR because concentrations of chromium remain in soil above the specified MTCA cleanup standard.

Response: Alternatives can comply with ARARs by eliminating exposure to contaminants through treatment, or by reducing and/or controlling risks through engineering controls such as capping, often in conjunction with institutional controls. S3 does meet the MTCA cleanup standards because it would control risks from direct exposure by a protective cap that would both prevent worker exposure and limit infiltration of chromium to ground water.

Comment: Page 16, it should be stated that protection of ground water will take longer under S5 (soil excavation) than S4 (soil flushing) and will result in additional ground water extraction, treatment, and O&M. The time frame for the overall ground-water cleanup may be the same, but the extraction system size and volume of water requiring treatment will continue to be larger. Rather than shrinking the plume over time by ground-water treatment, the soil contamination left under S5 will continue to dissolve into ground water and make the plume "larger for that much longer".

Response: EPA disagrees that protection of ground water will take longer under S5 than S4 or that the extraction system size and/or volume of water will increase. First, S5 will expedite ground-water cleanup by excavating the highest concentrations of chromium in soil that would otherwise be left to migrate to ground water under alternative S4. Second, as explained in EPA's response two comments above, optimization of the 200 gpm ground-water extraction system will include efforts to prevent migration of hexavalent chromium from the Boomsnub Soil OU to the down gradient ground-water plume using existing extraction wells. In addition, EPA expects to simultaneously reduce the areal extent of the ground-water plume within the 200 gpm capacity.

Comment: Page 18, cost table, S5 does not adequately acknowledge the O&M costs (referred to in the previous comment) associated with this alternative and the additional incremental cost of ground-water treatment associated with allowing some chromium in soils to migrate to ground water for treatment. There is O&M associated with S5, it's just transferred to the ground water treatment. A detailed cost benefit (or the additional costs) associated with this O&M should be considered.

Response: Without a ground-water alternative EPA would expect to spend approximately $376,227 for capital and O&M costs in addition to the $368,000 capital cost estimate for soil excavation at the 400 ppm remediation level. Because EPA is implementing a ground-water alternative, the cost of operating the ex-situ ground water treatment and associated capital costs are already factored into the GW4 cost estimate and no additional costs to alternative GW4 is expected. EPA's estimate of O&M cost for S5 were derived from FS alternative S4. Under S4, EPA assumed $30,000 (for two extraction wells at $15,000 each), and $346,227 for 3 years of O&M of the ion-exchange for ex-situ chromium treatment. O&M costs in S4 for the air stripper related to VOCs, work plan development costs, asphalt capping, work plan, and contingency costs would either not be relevant O&M items for S5 or are already included in the cost estimate for S5.

APPENDIX B
RISK ASSESSMENT TABLES

Appendix B
Risk Assessment Tables

Human Health-Soil

Table B-1 Occurrence, Distribution, And Selection Of Chemicals Of Concern Boomsnub Soil OU

Table B-2 Medium-Specific Exposure Point Concentration Summary Boomsnub Soil OU - Future

Table B-3 Summary Of Receptor Risks And Hazard Indices Reasonable Maximum Exposure Boomsnub Soil OU - Future Adult Worker Boomsnub Property Surface Soil

Table B-4 Summary Of Receptor Risks And Hazard Indices Reasonable Maximum Exposure Boomsnub Soil OU - Future Adult Worker Voorhies Surface Soil

Table B-5 Summary Of Receptor Risks And Hazard Indices Reasonable Maximum Exposure Boomsnub Soil OU - Future Adult Worker Railway Surface Soil

Table B-6 Summary Of Receptor Risks And Hazard Indices Reasonable Maximum Exposure Boomsnub Soil OU - Future Adult Worker Heuvel Surface Soil

Table B-7 Summary Of Receptor Risks And Hazard Indices Reasonable Maximum Exposure Boomsnub Soil OU - Future Adult Worker LaValley Property Surface Soil

Human Health-Ground Water

Table B-8 Occurrence, Distribution And Selection Of Chemicals Of Concern Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit

Table B-9 Medium-Specific Exposure Point Concentration Summary Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit - Future Ground Water (Alluvial Aquifer) MW-14E (97)

Table B-10 Medium-Specific Exposure Point Concentration Summary Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit - Future Ground Water (Upper Troutdale) AMW-24A (97)

Table B-11 Summary Of Receptor Risks And Hazards For COPCs Reasonable Maximum Exposure Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit-Future Child/Adult Resident MW-14E (97)

Table B-12 Summary Of Receptor Risks And Hazards For COPCs Reasonable Maximum Exposure Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit-Future Child/Adult Resident AMW-24 (97)

Table B-13 Summary Of Receptor Risks And Hazards For COPCs Reasonable Maximum Exposure Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit-Future Child Resident MW-14E (97)

Table B-14 Summary Of Receptor Risks And Hazards For COPCs Reasonable Maximum Exposure Boomsnub/Airco Superfund Site - Site-Wide Ground Water Operable Unit-Future Child Resident AMW-24 (97)

TABLE B-1

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN

BOOMSNUB SOIL OU

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil and Dust

CAS Number	Chemical	Minimum (a) Concentration	Minimum Qualifier	Maximum a Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background (b) Value	Screening (c) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COC Flag	Rationale for (d) Contaminant Selection
7440-47-3	Chromium	7.6		2,090	J	mg/kg	60.12,1	36/36	NU	2,090	28 83	211	c	—		Yes	ASL
18540-29-9	Chromium (VI)	2		67		mg/kg	24,102,1	16/23	2-2	67	NA	30	c	4.00E+02	(e)	Yes	ASL
16065-83-1	Chromium (III)	14		2,000		mg/kg	60,12,1	22/23	2-2	2,000	NA	211	N	4.00E+02	(e)	Yes	ASL
7439-92-1	Lead	10.9		2,580		mg/kg	60,12,1	23/23	NU	2,580	29.6	400	N	1.00E+03	(f)	Yes	ASL

(a) Minimum/maximum detected concentration.

(b) The value is the maximum concentration of the Clark County results (Ecology, 1994a).

(c) Residential Preliminary Remediation Goals (EPA, 1996a)

(d) Rationale Codes:
Selection reason:
Above Screening Levels (ASL)

(e) Values for chromium are from MTCA Method B Cleanup Levels for the protection of groundwater in soil. Exceedances of these values does not necessarily trigger requirements for cleanup action.

(f) Value for lead is from MTCA Method A Industrial soil criteria. Exceedances of these values does not necessarily trigger requirements for a cleanup action.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
C*=Carcinogenic (where N<100xC)
C**=Carcinogenic (where N<10xC)
COPC = Chemical of Potential Concern
J = Estimated Value
NU = Not Used; all samples were detected for the compound of concern

NA = Not applicable
N = Non-carcinogenic
ND = Not detected

TABLE B-2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY BOOMSNUB SOIL OU

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Points: Surface Soil On Individual Properties

Chemical of Concern	Boomsnub Property Surface Soil[a]	Voorhies Surface Soil[b]	Railway Surface Soil[c]	Heuvel Surface Soil[d]	La Valley Surface Soil[e]
Chromium, hexavalent	67	26	21	4	ND
Chromium, trivalent	2,000	1,500	990	68	51
Lead	2,580	1,150	2,250	65.6 J	51

J = indicates that concentration was estimated

[a] With the exception of chromium, a total of 11 samples were collected for chemical analyses. 23 samples were collected and analyzed for chromium on the Boomsnub property.
[b] A total of six surface soil samples were collected from the Voorhies property
[c] A total of six surface soil samples were collected from the Railway property.
[d] Only one sample was collected from the Heuvel property.
[e] With the exception of total chromium, two surface soil samples were collected from the LaValley property. Seven samples were collected for total chromium.

Maximum detected values were used. Data sets with fewer than 10 samples per exposure area provide poor estimates of the mean concentrations Supplemental Guidance to RAGS, Calculating the Concentration Term.

TABLE B-3
SUMMARY OF RECEPTOR RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB SOIL OU

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Cancer Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Boomsnub Property Surface Soil	Arsenic	2E-06	---	1E-06	3E-06	Arsenic	Skin	1.1E-02	---	6.4E-03	1.7E-02
			Chromium, hexavalent	---	---	---	---	Chromium, hexavalent	None Observed	6.6E-03	---	1.3E-02	2.0E-02
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	9.8E-04	---	4.9E-02	5.0E-02
			Benzo[a]anthracene	2E-07	---	5E-07	7E-07	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	2E-06	---	5E-06	7E-06	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	2E-07	---	6E-07	8E-07	Benzo[b]fluoranthene	---	---	---	---	---
			Dibenz[a,h]anthracene	1E-07	---	3E-07	4E-07	Dibenz[a,h]anthracene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	2E-07	---	5E-07	7E-07	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total	**4E-06**		**8E-06**	**1E-05**	**Total**		**1.8E-02**	---	**6.8E-02**	**8.7E-02**
	Air	Boomsnub Property Dust	Arsenic	---	6E-11	---	6E-11	Arsenic	Skin	---	---	---	---
			Chromium, hexavalent	---	1E-08	---	1E-08	Chromium, hexavalent	Nasal Septum	---	4.1E-06	---	4.1E-06
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	---	---	---	---
			Benzo[a]anthracene	---	7E-13	---	7E-13	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	---	7E-12	---	7E-12	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	---	8E-13	---	8E-13	Benzo[b]fluoranthene	---	---	---	---	---
			Dibenz[a,h]anthracene	---	4E-13	---	4E-13	Dibenz[a,h]anthracene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	---	7E-13	---	7E-13	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total		**1E-08**		**1E-08**	**Total**		---	**4.1E-06**	---	**4.1E-06**
						Total Risk Across Soil	1E-05	Total Hazard Index Across All Media and All Exposure Routes					8.7E-02
						Total Risk Across All Media and All Exposure Routes	1E-05						

--- = Not Applicable

TABLE B-4
SUMMARY OF RECEPTOR RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB SOIL OU

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Cancer Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Voorhies Surface Soil	Arsenic	1E-06	---	8E-07	2E-06	Arsenic	Skin	8.5E-03	---	4.8E-03	1.3E-02
			Chromium, hexavalent	---	---	---	---	Chromium, hexavalent	None Observed	2.5E-03	---	5.1E-03	7.6E-03
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	7.3E-04	---	3.7E-02	3.7E-02
			Benzo[a]anthracene	2E-08	---	4E-08	6E-08	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	1E-07	---	3E-07	4E-07	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	2E-08	---	6E-08	9E-08	Benzo[b]fluoranthene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	1E-08	---	4E-08	5E-08	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total	**1E-06**	---	**1E-06**	**3E-06**	**Total**		**1.2E-02**	---	**4.7E-02**	**5.8E-02**
Surface Soil	Air	Voorhies Dust	Arsenic	---	5E-11	---	5E-11	Arsenic	Skin	---	---	---	---
			Chromium, hexavalent	---	5E-09	---	5E-09	Chromium, hexavalent	Nasal Septum	---	1.6E-06	---	1.6E-06
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	---	---	---	---
			Benzo[a]anthracene	---	6E-14	---	6E-14	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	---	4E-13	---	4E-13	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	---	9E-14	---	9E-14	Benzo[b]fluoranthene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	---	5E-14	---	5E-14	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total	---	**5E-09**	---	**5E-09**	**Total**		---	**1.6E-06**	---	**1.6E-06**
					Total Risk Across Soil		3E-06	Total Hazard Index Across All Media and All Exposure Routes					5.8E-02
			Total Risk Across All Media and All Exposure Routes				3E-06						

--- = Not Applicable

TABLE B-5
SUMMARY OF RECEPTOR RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB SOIL OU

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Cancer Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Railway Surface Soil	Arsenic	8E-06	---	5E-06	1E-05	Arsenic	Skin	5.3E-02	---	3.2E-02	8.4E-02
			Chromium, hexavalent	---	---	---	---	Chromium, hexavalent	None Observed	2.1E-03	---	4.1E-03	6.2E-03
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	4.8E-04	---	2.4E-02	2.5E-02
			Benzo[a]anthracene	4E-08	---	1E-07	1E-07	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	4E-07	---	1E-06	1E-06	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	6E-08	---	1E-07	2E-07	Benzo[b]fluoranthene	---	---	---	---	---
			Dibenz[a,h]anthracene	4E-08	---	9E-08	1E-07	Dibenz[a,h]anthracene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	3E-08	---	8E-08	1E-07	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total	**9E-06**	**---**	**6E-06**	**2E-05**	**Total**		**5.5E-02**	**---**	**6.0E-02**	**1.2E-01**
Surface Soil	Air	Railway Dust	Arsenic	---	3E-10	---	3E-10	Arsenic	Skin	---	---	---	---
			Chromium, hexavalent	---	4E-09	---	4E-09	Chromium, hexavalent	None Observed	---	1.3E-06	---	1.3E-06
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	---	---	---	---
			Benzo[a]anthracene	---	1E-13	---	1E-13	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	---	1E-12	---	1E-12	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	---	2E-13	---	2E-13	Benzo[b]fluoranthene	---	---	---	---	---
			Dibenz[a,h]anthracene	---	1E-13	---	1E-13	Dibenz[a,h]anthracene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	---	1E-13	---	1E-13	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total	**---**	**4E-09**	**---**	**4E-09**	**Total**		**---**	**1.3E-06**	**---**	**1.3E-06**
						Total Risk Across Soil	2E-05	Total Hazard Index Across All Media and All Exposure Routes					1.2E-01
						Total Risk Across All Media and All Exposure Routes	2E-05						

--- = Not Applicable

TABLE B-6
SUMMARY OF RECEPTOR RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB SOIL OU

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Cancer Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Heuvel Surface Soil	Chromium, hexavalent	---	---	---	---	Chromium, hexavalent	None Observed	3.9E-04	---	7.8E-04	1.2E-03
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	3.3E-05	---	1.7E-03	1.7E-03
			Lead	---	---	---	0E+00	Lead	---	---	---	---	---
			Total	**0E+00**	**---**	**0E+00**	**0E+00**	**Total**		**4.2E-04**	**---**	**2.4E-03**	**2.9E-03**
Surface Soil	Air	Heuvel Dust	Chromium, hexavalent	---	7E-10	---	7E-10	Chromium, hexavalent	None Observed	---	2.5E-07	---	2.5E-07
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	---	---	---	---
			Lead	---	---	---	0E+00	Lead	---	---	---	---	---
			Total	**---**	**7E-10**	**---**	**7E-10**	**Total**		**---**	**2.5E-07**	**---**	**2.5E-07**
						Total Risk Across Soil	7E-10					Total Hazard Index Across All Media and All Exposure Routes	2.9E-03
						Total Risk Across All Media and All Exposure Routes	7E-10						

--- = Not Applicable

TABLE B-7
SUMMARY OF RECEPTOR RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB SOIL OU

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Cancer Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	LaValley Property Surface Soil	Arsenic	1E-06	---	7E-07	2E-06	Arsenic	Skin	7.7E-03	---	4.6E-03	1.2E-02
			Chromium, hexavalent	---	---	---	---	Chromium, hexavalent	None Observed	1.2E-04	---	2.4E-04	3.7E-04
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	2.5E-05	---	1.2E-03	1.3E-03
			Lead	---	---	---	---	Lead	---	---	---	---	---
			Benzo[a]anthracene	5E-09	---	1E-08	2E-08	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	5E-08	---	1E-07	2E-07	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	1E-08	---	3E-08	4E-08	Benzo[b]fluoranthene	---	---	---	---	---
			Dibenz[a,h]anthracene	2E-08	---	5E-08	7E-08	Dibenz[a,h]anthracene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	6E-09	---	2E-08	2E-08	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total	**1E-06**	**0E+00**	**1E-06**	**2E-06**	**Total**		**7.8E-03**	**---**	**6.1E-03**	**1.4E-02**
	Air	LaValley Property Dust	Arsenic	---	4E-11	---	4E-11	Arsenic	Skin	---	---	---	---
			Chromium, hexavalent	---	3E-11	---	3E-11	Chromium, hexavalent	Nasal Septum	---	7.7E-08	---	7.7E-08
			Chromium, trivalent	---	---	---	---	Chromium, trivalent	None Observed	---	---	---	---
			Lead		---		---	Lead			---		---
			Benzo[a]anthracene	---	2E-14	---	2E-14	Benzo[a]anthracene	---	---	---	---	---
			Benzo[a]pyrene	---	2E-13	---	2E-13	Benzo[a]pyrene	---	---	---	---	---
			Benzo[b]fluoranthene	---	4E-14	---	4E-14	Benzo[b]fluoranthene	---	---	---	---	---
			Dibenz[a,h]anthracene	---	7E-14	---	7E-14	Dibenz[a,h]anthracene	---	---	---	---	---
			Indeno[1,2,3-cd]pyrene	---	2E-14	---	2E-14	Indeno[1,2,3-cd]pyrene	---	---	---	---	---
			Total		**8E-11**		**8E-11**	**Total**		**---**	**7.7E-08**	**---**	**7.7E-08**
						Total Risk Across Soil	2E-06	Total Hazard Index Across All Media and All Exposure Routes					1.4E-02
						Total Risk Across All Media and All Exposure Routes	2E-06						

--- = Not Applicable

TABLE B-8
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF CONCERN
BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Current/Future
Medium: Ground Water All Wells (1995 - 1997)
Exposure Medium: Ground Water (Alluvial Aquifer)
Exposure Point: Tap Water

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	Rationale for Contaminant Selection (4)
7440473	Chromium (Total)	1.5		51000		ug/L	MW-20D	464/588	0.2 - 6.1	51000	5 (ii)	50	1.00E+02	MCL	ASL
18540299	Chromium, Hexavalent (Total)	778	J,J	37500	J,J	ug/L	MW-20D	46/46		37500	NA	182.5 nc	8.00E+01	MTCA B	ASL
75274	Bromodichloromethane	0.15	J,J	14.2	J,J	ug/L	MW-15E	17/437	0.3 - 200	14.2		0.181 ca	7.06E-01	MTCA B	ASL
56235	Carbon Tetrachloride	0.12	J,J	23.8		ug/L	MW-1A	25/437	0.4 - 200	23.8		0.171 ca*	3.37E-01	MTCA B	ASL
96128	1,2-Dibromo-3-Chloropropane	1	J,J	1	J,J	ug/L	MW-13C	1/391	0.5 - 250	1		0.05 ca*	2.00E-01	MCL	ASL
124481	Dibromochloromethane	0.12	J,J	2.6		ug/L	MW-5B	9/437	0.3 - 200	2.6		1.0 ca	5.21E-01	MTCA B	ASL
107062	1,2-Dichloroethane	0.16	J,J	18.6	J,J	ug/L	AMW-12A DUP	57/437	0.4 - 200	18.6		0.123 ca	4.81E-01	MTCA B	ASL
75354	1,1-Dichloroethene	0.18	J,J	352.7		ug/L	MW-14E	249/437	0.4 - 200	352.7		0.046 ca	7.29E-02	MTCA B	ASL
87683	Hexachlorobutadiene	2	J,J	2	J,J	ug/L	MW-13C	1/391	0.12 - 250	2		0.862 ca*	5.61E-01	MTCA B	ASL
127184	Tetrachloroethene	0.059	J,J	254		ug/L	MW-14E	464/637	0.4 - 200	254		1.1 ca	5.00E+00	MCL	ASL
71556	1,1,1-Trichloroethane	0.16	J,J	1110		ug/L	AMW-12A	317/437	0.4 - 200	1110		792 nc	2.00E+02	MCL	ASL
79016	Trichloroethene	0.14	J,J	19300	J,J	ug/L	AMW-12A	559/637	0.3 - 7.3	19300		1.6 ca*	5.00E+00	MCL	ASL

(1) Minimum/maximum detected concentration.

(2) NA - Refer to supporting information for background discussion.
(i) Background values derived from (USGS, 1998) - Quality of Ground Water in Clark County, Washington.
(ii) Background values derived from local background well (AMW-7A).

(3) USEPA Region 9 Preliminary Remediation Goals (PRGs) 1996, August. (EPA, 1996a)
PRG concentrations based on cancer risk are indicated by "ca". PRG concentrations based on noncarcinogenic health threats are indicated by "nc".
ca* = carcinogenic (where N<100xC)

(4) Rationale Codes Selection Reason:
Above Screening Levels (ASL)

Definitions: NA = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE B-9
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Future
Medium: Ground Water MW-14E (97)
Exposure Medium: Ground Water (Alluvial Aquifer)
Exposure Point: Tap Water

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic (Total)	ug/L	2.37	NA	2.6		ug/L	2.37	Average	Average	NA	NA	NA
Chromium (Total)	ug/L	20267	NA	21200		ug/L	20267	Average	Average	NA	NA	NA
Carbon Tetrachloride	ug/L	1	NA	1		ug/L	1	Average	Average	NA	NA	NA
Chloroform	ug/L	0.7	NA	0.7		ug/L	0.7	Average	Average	NA	NA	NA
1,1-Dichloroethene	ug/L	21.13	NA	31		ug/L	21.13	Average	Average	NA	NA	NA
Cis-1,2-Dichloroethene	ug/L	21.97	NA	26		ug/L	21.97	Average	Average	NA	NA	NA
Fluorotrichloromethane	ug/L	250	NA	270		ug/L	250	Average	Average	NA	NA	NA
Tetrachloroethene	ug/L	130	NA	140		ug/L	130	Average	Average	NA	NA	NA
1,1,1-Trichloroethane	ug/L	15.37	NA	20		ug/L	15.37	Average	Average	NA	NA	NA
Trichloroethene	ug/L	6113	NA	6540		ug/L	6113	Average	Average	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N)

The list of COPCs listed is based on only those chemicals that were detected in this well for this particular year.

NA = Not Applicable (because of the limited amount of data points, a 95% UCL and a CTE EPC were not derived); EPCs = Exposure Point Concentrations

TABLE B-10

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Future
Medium: Ground Water AMW-24A (97)
Exposure Medium: Ground Water (Upper Troutdale)
Exposure Point: Tap Water

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic (Total)	ug/L	0.58	NA	0.59		ug/L	0.58	Average	Average	NA	NA	NA
Cadmium (Total)	ug/L	0.06	NA	0.068		ug/L	0.06	Average	Average	NA	NA	NA
Chromium (Total)	ug/L	5.2	NA	5.2		ug/L	5.2	Average	Average	NA	NA	NA
Manganese (Total)	ug/L	229	NA	235		ug/L	229	Average	Average	NA	NA	NA
1,1-Dichloroethene	ug/L	1.7	NA	2.1		ug/L	1.7	Average	Average	NA	NA	NA
Cis-1,2-Dichloroethene	ug/L	3.77	NA	4.3		ug/L	3.77	Average	Average	NA	NA	NA
1,1,1-Trichloroethane	ug/L	2.03	NA	2.1		ug/L	2.03	Average	Average	NA	NA	NA
Trichloroethene	ug/L	9.57	NA	11.7		ug/L	9.57	Average	Average	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean o

The list of COPCs listed is based on only those chemicals that were detected in this well for this particular year

NA = Not Applicable (because of the limited amount of data points, a 95% UCL and a CTE EPC were not derived); EPCs = Exposure Point Concentrations

TABLE B-11
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Tap Water	MW-14E (97)	Arsenic (Total)	5E-05	-	1E-07	5E-05	Arsenic (Total)	Skin	2.2E-01	-	6.2E-04	2.2E-01
			Chromium (Total)	NC	-	NC	NC	Chromium (Total)	None Observed	1.1E+02	-	3.2E+00	1.1E+02
			Carbon Tetrachloride	2E-06	-	5E-07	2E-06	Carbon Tetrachloride	Liver	3.9E-02	-	1.2E-02	5.1E-02
			Chloroform	6E-08	-	5E-09	7E-08	Chloroform	Liver	1.9E-03	-	1.9E-04	2.1E-03
			1,1-Dichloroethene	2E-04	-	2E-05	2E-04	1,1-Dichloroethene	Liver	6.4E-02	-	9.5E-03	7.4E-02
			Cis-1,2-Dichloroethene	NC	-	NC	NC	Cis-1,2-Dichloroethene	Blood Chemistry	6.0E-02	-	5.6E-03	6.6E-02
			Fluorotrichloromethane	NC	-	NC	NC	Fluorotrichloromethane	Histopathology	2.3E-02	-	4.8E-03	2.8E-02
			Tetrachloroethene	1E-04	-	6E-05	2E-04	Tetrachloroethene	Liver	3.6E-01	-	2.6E-01	6.1E-01
			1,1,1-Trichloroethane	NC	-	NC	NC	1,1,1-Trichloroethane	CNS	2.1E-02	-	4.3E-03	2.5E-02
			Trichloroethene	1E-03	-	2E-04	1E-03	Trichloroethene	--	2.8E+01	-	5.3E+00	3.3E+01
			(Total)	1E-03	0E+00	3E-04	2E-03	(Total)		1.4E+02	0.0E+00	8.8E+00	1.5E+02
	Air	Volatilization from Tap Water Use	Carbon Tetrachloride	-	3E-06	-	3E-06	Carbon Tetrachloride	Liver	-	1.8E-01	-	1.8E-01
			Chloroform	-	4E-06	-	4E-06	Chloroform	Liver	-	7.2E-03	-	7.2E-03
			1,1-Dichloroethene	-	2E-04	-	2E-04	1,1-Dichloroethene	Liver	-	2.4E-01	-	2.4E-01
			Cis-1,2-Dichloroethene	-	NC	-	NC	Cis-1,2-Dichloroethene	Blood Chemistry	-	2.3E-01	-	2.3E-01
			Fluorotrichloromethane	-	NC	-	NC	Fluorotrichloromethane	Histopathology	-	8.6E-02	-	8.6E-02
			Tetrachloroethene	-	2E-05	-	2E-05	Tetrachloroethene	Liver	-	1.3E+00	-	1.3E+00
			1,1,1-Trichloroethane	-	NC	-	NC	1,1,1-Trichloroethane	CNS	-	5.5E-03	-	5.5E-03
			Trichloroethene	-	2E-03	-	2E-03	Trichloroethene	--	-	1.0E+02	-	1.0E+02
			(Total)	0E+00	3E-03	0E+00	3E-03	(Total)		0.0E+00	1.1E+02	0.0E+00	1.1E+02
			Total Risk Across Ground Water				4E-03	Total Hazard Index Across All Media and All Exposure Routes					2.6E+02
			Total Risk Across All Media and All Exposure Routes				4E-03						

NC = Non Carcinogen; NV = Non Volatile;

TABLE B-12
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Tap Water	AMW-24 (97)	Arsenic (Total)	1E-05	-	3E-08	1E-05	Arsenic (Total)	Skin	5.3E-02	-	1.5E-04	5.3E-02
			Cadmium (Total)	NC	-	NC	NC	Cadmium (Total)	Kidney	3.4E-03	-	2.0E-04	3.6E-03
			Chromium (Total)	NC	-	NC	NC	Chromium (Total)	None Observed	2.8E-02	-	8.2E-04	2.9E-02
			Manganese (Total)	NC	-	NC	NC	Manganese (Total)	CNS	4.5E-02	-	2.6E-04	4.5E-02
			1,1-Dichloroethene	2E-05	-	2E-06	2E-05	1,1-Dichloroethene	Liver	5.2E-03	-	7.7E-04	5.9E-03
			Cis-1,2-Dichloroethene	NC	-	NC	NC	Cis-1,2-Dichloroethene	Blood Chemistry	1.0E-02	-	9.6E-04	1.1E-02
			1,1,1-Trichloroethane	NC	-	NC	NC	1,1,1-Trichloroethane	CNS	2.8E-03	-	5.7E-04	3.4E-03
			Trichloroethene	2E-06	-	3E-07	2E-06	Trichloroethene	--	4.4E-02	-	8.2E-03	5.2E-02
			(Total)	3E-05	0E+00	2E-06	3E-05	(Total)		1.9E-01	0.0E+00	1.2E-02	2.0E-01
	Air	Volatilization from Tap Water Use	1,1-Dichloroethene	-	2E-05	-	2E-05	1,1-Dichloroethene	Liver	-	1.9E-02	-	1.9E-02
			Cis-1,2-Dichloroethene	-	NC	-	NC	Cis-1,2-Dichloroethene	Blood Chemistry	-	3.9E-02	-	3.9E-02
			1,1,1-Trichloroethane	-	NC	-	NC	1,1,1-Trichloroethane	CNS	-	7.3E-04	-	7.3E-04
			Trichloroethene	-	4E-06	-	4E-06	Trichloroethene	--	-	1.6E-01	-	1.6E-01
			(Total)	0E+00	2E-05	0E+00	2E-05	(Total)		0.0E+00	2.2E-01	0.0E+00	2.2E-01
						Total Risk Across Ground Water	6E-05					Total Hazard Index Across All Media and All Exposure Routes	4.3E-01
						Total Risk Across All Media and All Exposure Routes	6E-05						

NC = Non Carcinogen; NV = Non Volatile;

TABLE B-13
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Noncarcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Tap Water	MW-14E (97)	Arsenic (Total)	2E-05	-	4E-08	2E-05	Arsenic (Total)	Skin	5.0E-01	-	9.5E-04	5.1E-01
			Chromium (Total)	NC	-	NC	NC	Chromium (Total)	None Observed	2.6E+02	-	4.9E+00	2.6E+02
			Carbon Tetrachloride	7E-07	-	1E-07	9E-07	Carbon Tetrachloride	Liver	9.1E-02	-	1.8E-02	1.1E-01
			Chloroform	2E-08	-	1E-09	2E-08	Chloroform	Liver	4.5E-03	-	2.8E-04	4.8E-03
			1,1-Dichloroethene	7E-05	-	7E-06	8E-05	1,1-Dichloroethene	Liver	1.5E-01	-	1.5E-02	1.6E-01
			Cis-1,2-Dichloroethene	NC	-	NC	NC	Cis-1,2-Dichloroethene	Blood Chemistry	1.4E-01	-	8.5E-03	1.5E-01
			Fluorotrichloromethane	NC	-	NC	NC	Fluorotrichloromethane	Histopathology	5.3E-02	-	7.3E-03	6.1E-02
			Tetrachloroethene	4E-05	-	2E-05	5E-05	Tetrachloroethene	Liver	8.3E-01	-	3.9E-01	1.2E+00
			1,1,1-Trichloroethane	NC	-	NC	NC	1,1,1-Trichloroethane	CNS	4.9E-02	-	6.5E-03	5.6E-02
			Trichloroethene	4E-04	-	5E-05	4E-04	Trichloroethene	--	6.5E+01	-	8.0E+00	7.3E+01
			(Total)	5E-04	0E+00	7E-05	6E-04	(Total)		3.3E+02	0.0E+00	1.3E+01	3.4E+02
	Air	Volatilization from Tap Water Use	Carbon Tetrachloride	-	2E-06	-	2E-06	Carbon Tetrachloride	Liver	-	6.2E-01	-	6.2E-01
			Chloroform	-	2E-06	-	2E-06	Chloroform	Liver	-	2.5E-02	-	2.5E-02
			1,1-Dichloroethene	-	1E-04	-	1E-04	1,1-Dichloroethene	Liver	-	8.3E-01	-	8.3E-01
			Cis-1,2-Dichloroethene	-	NC	-	NC	Cis-1,2-Dichloroethene	Blood Chemistry	-	7.7E-01	-	7.7E-01
			Fluorotrichloromethane	-	NC	-	NC	Fluorotrichloromethane	Histopathology	-	2.9E-01	-	2.9E-01
			Tetrachloroethene	-	8E-06	-	8E-06	Tetrachloroethene	Liver	-	4.6E+00	-	4.6E+00
			1,1,1-Trichloroethane	-	NC	-	NC	1,1,1-Trichloroethane	CNS	-	1.9E-02	-	1.9E-02
			Trichloroethene	-	1E-03	-	1E-03	Trichloroethene	--	-	3.6E+02	-	3.6E+02
			(Total)	0E+00	1E-03	0E+00	1E-03	(Total)		0.0E+00	3.7E+02	0.0E+00	3.7E+02
						Total Risk Across Ground Water	2E-03					Total Hazard Index Across All Media and All Exposure Routes	7.0E+02
						Total Risk Across All Media and All Exposure Routes	2E-03						

NC = Noncarcinogen; NV = Non-volatile; OU = Operable Unit

TABLE B-14
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
BOOMSNUB/AIRCO SUPERFUND SITE - SITE-WIDE GROUND WATER OPERABLE UNIT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground Water	Tap Water	AMW-24 (97)	Arsenic (Total)	5E-06	-	9E-09	5E-06	Arsenic (Total)	Skin	1.2E-01	-	2.3E-04	1.2E-01
			Cadmium (Total)	NC	-	NC	NC	Cadmium (Total)	Kidney	8.0E-03	-	3.0E-04	8.3E-03
			Chromium (Total)	NC	-	NC	NC	Chromium (Total)	None Observed	6.6E-02	-	1.2E-03	6.8E-02
			Manganese (Total)	NC	-	NC	NC	Manganese (Total)	CNS	1.0E-01	-	3.9E-04	1.0E-01
			1,1-Dichloroethene	6E-06	-	5E-07	6E-06	1,1-Dichloroethene	Liver	1.2E-02	-	1.2E-03	1.3E-02
			Cis-1,2-Dichloroethene	NC	-	NC	NC	Cis-1,2-Dichloroethene	Blood Chemistry	2.4E-02	-	1.5E-03	2.6E-02
			1,1,1-Trichloroethane	NC	-	NC	NC	1,1,1-Trichloroethane	CNS	6.5E-03	-	8.6E-04	7.4E-03
			Trichloroethene	6E-07	-	7E-08	6E-07	Trichloroethene	--	1.0E-01	-	1.3E-02	1.1E-01
			(Total)	1E-05	0E+00	6E-07	1E-05	(Total)		4.5E-01	0.0E+00	1.8E-02	4.7E-01
	Air	Volatilization from Tap Water Use	1,1-Dichloroethene	-	9E-06	-	9E-06	1,1-Dichloroethene	Liver	-	6.6E-02	-	6.6E-02
			Cis-1,2-Dichloroethene	-	NC	-	NC	Cis-1,2-Dichloroethene	Blood Chemistry	-	1.3E-01	-	1.3E-01
			1,1,1-Trichloroethane	-	NC	-	NC	1,1,1-Trichloroethane	CNS	-	2.5E-03	-	2.5E-03
			Trichloroethene	-	2E-06	-	2E-06	Trichloroethene	--	-	5.6E-01	-	5.6E-01
			(Total)	0E+00	1E-05	0E+00	1E-05	(Total)		0.0E+00	7.6E-01	0.0E+00	7.6E-01
					Total Risk Across Ground Water		2E-05		Total Hazard Index Across All Media and All Exposure Routes				1.2E+00
				Total Risk Across All Media and All Exposure Routes			2E-05						

NC = Non Carcinogen; NV = Non Volatile;